

Union Pacific Railroad.

REPORT

OF THE

CHIEF ENGINEER,

WITH ACCOMPANYING

RÉPORTS OF DIVISION ENGINEERS,

FOR 1866.

WASHINGTON, D. C.
PHILP & SOLOMONS.
1868.



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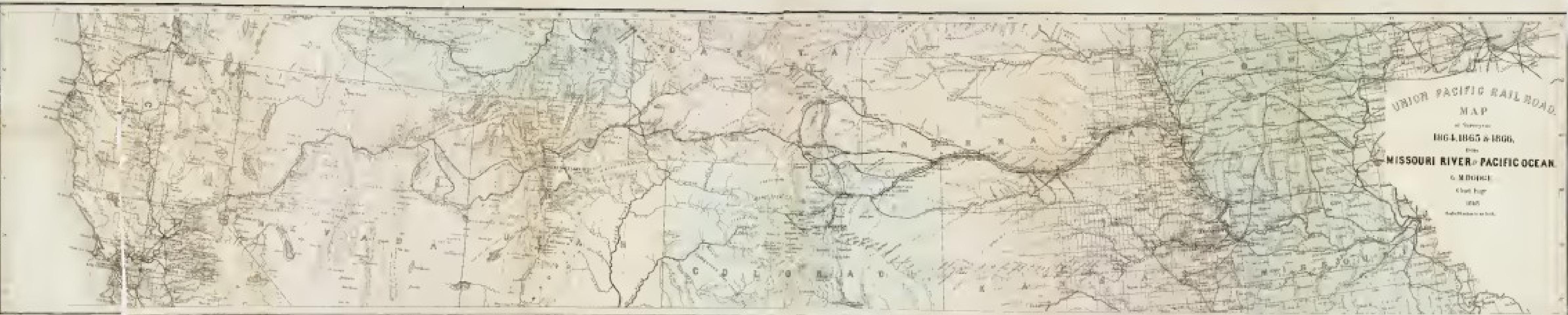
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UNION PACIFIC RAIL ROAD
MAP
of the
LINES
from
MISSOURI RIVER to PACIFIC OCEAN.

G. M. DODGE
Chief Engineer
1865



Graff

The New
The Everett S.
of West

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UNION PACIFIC RAILROAD.

UNION PACIFIC RAILROAD COMPANY,
ENGINEER'S OFFICE,
OMAHA, NEB., June 19, 1867.

OLIVER AMES, Esq., *Prest. U. P. R. R. Co.*,

20 Nassau street, New York:

DEAR SIR: I have the honor of submitting the detailed report of the operations of the engineering department of the U. P. R. R. for the year 1866.

In giving instructions for the year, I endeavored to concentrate the work for the different parties with the view of deciding, beyond a doubt, upon the best line from Fort Kearney to the west base of the Rocky Mountains. Knowing that the crossing of the mountains adopted by us would, to a great extent, control the selection of a line approaching them from the east, all our energies were put forth to determine that question at the earliest practicable moment.

In assigning the chiefs of parties to their work, I placed Mr. Jas. A. Evans in charge of the line over the Black Hills range of the Rocky Mountains; Mr. P. T. Brown, chief assistant, in charge of surveys up the Republican and South Platte rivers, and the surveys over the Rocky Mountains west of Denver; Mr. L. L. Hills was placed in charge of the location up the Platte valley, and lines between Platte and Lodge Pole valleys; Mr. Bates had charge of the surveys west of Salt Lake; Mr. House had charge of the Omaha office and the surveys required of me on that portion of the line being built, the laying off of depot towns, and procuring right of way.

In a separate report, of November, 1866, the result of my examination of lines over the Rocky Mountains and the

eastern approach is fully set forth, and the line recommended and adopted was on the north side of Platte river to the mouth of Lodge Pole; thence up that stream 105 miles; thence due west, crossing the divide between Lodge Pole and Crow creeks; thence over the mountains, on the Crow creek and Lone Tree divide-line, entering the Laramie plains near Willow Springs; thence to the crossing of Laramie river, near Fort Sanders.

Mr. Bates's party made surveys west of Salt Lake, in order to determine in our own minds the route for the road to take through that country, so that in case it should have any controlling influence on the route east of Salt Lake, we might have full knowledge of the fact, and in our location be governed accordingly.

The division engineers and chiefs of parties set forth their work through the summer in detail, and relieve me from

- the necessity of explaining the different lines or discussing the different surveys. I shall, therefore, only glance at the prominent features, preferring to let each chief of party have full credit for the work performed, and set it forth in his own way.

SURVEYS OF JAMES A. EVANS, DIVISION ENGINEER.

Mr. Evans, in the early part of the season, ran several lines between the Republican and Platte rivers. He was then ordered by me to turn over his party to Mr. P. T. Brown, first assistant engineer, assume charge of the lines in the Black Hills, and to obtain the best practicable line over the mountains. The instructions appear fully in his report. I subsequently sent instructions directing a careful examination of the country from Evans's Pass almost due east. My knowledge of that country indicated to me that we should seek a crossing of the mountains somewhere in that vicinity; and the examination of the mountains on the several lines discussed in Mr. Evans's report of 1864-'5, and his report of this year, shows that the line known as "the Lone Tree and Crow creek line" was superior to all others.

It is the line discussed in my report of November, 1866, and adopted by the company.

The difficulties encountered in running a line through Laramie cañon were enough to deter any person from undertaking the project; but Mr. Evans pushed through, taking three weeks to run 25 miles of the cañon—a narrow, wild, precipitous gorge, and never before passed by man. Everything had to be packed by the men, as pack mules could not find footing in the gorge. He demonstrated the impracticability of this line, although the Laramie river makes a thorough cut through the range, heading west of the mountains, and emptying into the Platte river east of it, indicating, before examination, a means of avoiding the high grades necessary to cross the mountains.

In examining the Crow creek country his party were thrown into a country never before developed, and we found that the prevalent idea formed of this country, as to its general character, was entirely erroneous. The line run down Crow creek was impracticable from bad direction, and was abandoned. It, however, aided us in determining the main line of the road; also, it developed fully a portion of the country through which a branch to Denver might be built, and determined the extent and vein of the coal and iron fields of that portion of Colorado.

During the winter Mr. Evans's party was encamped in the Black Hills, for the purpose of examining minutely the country through which we had determined to build the road, to develop and cross-section the country immediately along the line, and especially to note the winds, currents, snow, and rain of that high altitude during the winter months. So much had been said about impassable snow-banks, extreme cold, high winds, &c., that I deemed it best to determine these questions fully. The past winter has been the severest for years. The daily journal kept of the fall of snow, prevalent wind and weather, demonstrates conclusively that we shall meet with no obstacles from these sources but what we can easily overcome, and that there will be no greater obstructions in running this road than those encountered in our

Eastern and Northwestern States, as Mr. Evans's party took the field in April and remained in it during the entire year—a feat that I was assured by old experienced mountaineers could not be accomplished, but which my own experience on the plains and in the mountains convinced me was possible; and which was done without suffering or detriment to the party, and to the great benefit of the company.

During the time they could not keep the field they built a good two-story house and warehouse, at Fort Sanders, for our future use, so that we can hereafter keep our party there in the winter, and not be obliged to bring them all to Omaha, at great loss of time and at great expense.

The line known as the Crow creek and Lone Tree divide-line, with its low grades, its cheapness and alignment, as compared with all others, is very creditable to the perseverance, ability, and professional skill of Mr. Evans. It was obtained after spending three years in that region, and after bending all our energies this year to the fulfillment of that object; it was the key to all our work for 1867; and the possession of it lifted grave doubts from our minds, and decided, beyond all question, that it was the line which should be adopted by the company. Mr. Evans's party run 623.6 miles instrumental lines, and in marches and reconnoisances 956 miles.

SURVEYS OF P. T. BROWN, FIRST ASSISTANT ENGINEER.

Mr. Evans's party was turned over to Mr. P. T. Brown, in June, at Fort Kearney, and he was instructed to develop the country up the Republican Fork, and connect with the South Platte line near the mouth of Beaver creek, then run up the Platte to Denver, there to await instructions for the surveys over the mountains. In making a general organization of the work for the summer, I had assigned to Mr. Brown the development of the Republican valley, the Platte valley from Fort Morgan to Denver, and the lines west of Denver crossing the main range of the Rocky Mountains. Knowing the anxiety of the company to build their road, if

practicable, through Denver and the mining regions of Colorado, I determined to exhaust the question of the practicability of a line west from Denver, and to develop the entire country from Fort Kearney to Middle Park. The result of the examinations is, that no line can be obtained through this section of the Rocky Mountains that compares with the lines adopted by the company, which are shorter, cheaper, of better grades, &c.

I gave the lines over the mountains west of Denver a thorough examination, and our efforts were to obtain a line across the mountains in that vicinity that we could build on. I knew all the sympathies of the company were in that direction, but I was obliged, reluctantly, to report against that route, the engineering difficulties being such, when compared with other routes, that it was not practicable for the company to overcome them.

Mr. Brown, in his report, fully develops the prominent features of that country, its resources, and its practicability for railroads. In comparing the line up Lodge Pole, and west, with the line over the main range of the Rocky Mountains, *via* Berthoud Pass, although I did not, in my report of November, 1866, consider the country from the mountains to Salt Lake, yet, to satisfy myself, I did give that question a careful examination, and we found that, after passing the main range of the mountains west of Denver, we had greater obstacles to overcome, before reaching Green river, on that line, than on the line *via* Laramie plains. Our surveys also demonstrate that, to make a successful crossing of the Wasatch range, we are forced to cross Green river as far north as the mouth of Black's Fork or Bitter creek, the point where the line going west from Laramie plains crosses, thus increasing the distance some 100 miles over the direct route adopted by the company. The snows in the Rocky Mountains, at Berthoud Pass and Hog's Back, were such that, in September, our parties were driven off the mountains, and during the winter the passes west of Denver are impassable for foot or horseman. On the line west of Denver we have to rise 10,000 feet to reach grade-point and

mouth of tunnel, while on our adopted line we only reach an elevation of 8,200 feet, 5,000 feet of the rise on the Berthoud Pass line (the lowest tunnel we can get) being made in 58 miles. The tunnel on the Hog's Back is some shorter, if we could rise to the proper point for grade and get down on the west side; but the distance is less on this line than on Berthoud Pass line; and, in descending from mouth of tunnel, on the west side of the mountains, it takes 15 miles of maximum grades, with very heavy work.

That portion of the line between Latham and Denver run by Mr. Brown becomes common to all the branches from our road to Denver, the only question being whether we shall keep the east or west side of the Platte river. After Mr. Brown had finished his surveys in the mountains, I sent from La Porte instructions to move with his party to the north of Lodge Pole creek, and locate the line I had concluded to adopt to the east base of the mountains, some 105 miles up Lodge Pole, sending him profiles and map of the preliminary run by Mr. Evans up that valley in the early part of the season. He moved immediately to Fort Sedgwick, obtained his escort, and located about 105 miles of the adopted line up Lodge Pole creek, finishing his work in December, after frost and snow had come. During the surveys in the mountains and up Lodge Pole creek, Mr. Brown's party suffered great hardships. Once in the mountains they had to abandon everything and seek safety in the valley. As soon as the storm was over they returned, found their stock in the Middle Park, and finished their work.

Mr. Brown's party run over 500 miles of line, 100 miles being mountain work and 100 final location.

SURVEYS OF L. L. HILLS, FIRST ASSISTANT ENGINEER.

Mr. L. L. Hills entered the field as first assistant to Mr. D. H. Ainsworth, division engineer, who located the third hundred miles, and resigned to accept position in the C. R. and P. R. R. Mr. Ainsworth's location was approved, and immediately put under contract. On leaving, I instructed

Mr. Ainsworth to turn over the party to Mr. Hills, and sent Mr. Hills the following instructions:

"L. L. HILLS,

"Assistant Engineer, Cottonwood:

" Your party will continue location up the north side of South Platte to Lodge Pole creek. In making this location you must give the valley a thorough examination, and settle upon and locate the best line that can be obtained. The crossing of North Platte obtained by Mr. Ainsworth is good, except the direction. Try other crossings, and get the best you can for direction. Shall want to hear from you often, and get profile and alignment every 20 miles.

"(Signed)

G. M. DODGE,

"Chief Engineer."

Mr. Hills located up to the mouth of Pawnee creek, some 200 miles west of North Platte river, when, desiring to fully develop the country between Lodge Pole and South Platte river, to decide upon the best approach to an adopted line crossing the mountains, and the best and most feasible route for the branch from Denver to the adopted line, I sent him the following instructions:

"LA PORTE, Oct. 7, 1866.

"L. L. HILLS,

"Assistant Engineer U. P. R. R., Junction:

" Mr. Evans's party has returned from running the line down Crow creek.

" It appears from Mr. O'Neil's notes that Crow creek runs about due east for 35 miles, to station 2690; then, for 16 miles, to station 3555, it runs southeast; then it runs northwest to station 3833; then south to Platte, 24 miles; valley part of the way bad and crooked. After running your line up Pawnee creek to intersection with Evans's Crow creek line, I want you to examine the country between Cache la Poudre, or Lone Tree, and Pawnee creek, so as to get the best line possible to Evans's Crow creek crossing, having in view a

main line to the east, also a connection with Denver by a branch from that crossing. Mr. O'Neil says a good line can be got by starting out of his line in Crow creek, at or near station 3555, and taking the divide between Crow creek and Cut Bluff creek. He ran out on that divide 9 miles. Continue his line to the Platte, keeping east of Crow creek.

"At station 1900 you can get out of Crow creek to the west, and run down on the divide towards the mouth of Cache la Poudre. At station 2072 a large basin makes out west of Crow creek, and you will have to turn White Bluffs to avoid its rim.

"It is very important that we should fully develop the country east of Evans's line down Crow creek and west of it towards Cache la Poudre, and, if necessary to do it, you can spend the rest of the season in running lines through that country. Mr. Evans leaves to-day for his crossing of Crow creek, to run across to Lodge Pole. He will then be at work west of Crow creek in Black Hills.

"(Signed)

G. M. DODGE,

"Chief Engineer."

Mr. Hills's surveys demonstrated the impracticability of any approach to the Crow creek and Lone Tree divide-line over the high country from the east, south of Lodge Pole creek; also, the feasibility of a branch from several points on the adopted line to Denver. It will take a further examination of the country west of Crow creek to determine fully the best line for the branch, which surveys will be made during the coming season. Mr. Hills's party located, during the season, 273.5 miles, and run, of preliminary line, 450 miles, making a total of 723.5 miles; adding the amount run by Mr. Ainsworth, of located line, 100 miles, gives a total for the season's work of 823.5 miles—certainly a very creditable showing. Their work being mostly plain work, with no mountains to encounter, enabled them to accomplish more miles than any one of the other parties. The party was composed of young men of more than ordinary ability.

SURVEYS OF J. E. HOUSE, DIVISION ENGINEER.

In addition to the engineering duties, there has devolved upon me the charge of right of way, depot towns, and bridge and river surveys. Mr. House has had direct charge of this department. In addition to his other duties, he has laid out and brought into market the depot towns, some twelve in number. A system of record and sale has been adopted, and each depot has now a town attached, giving all an opportunity to purchase and settle at very reasonable rates. Lots are sold to settlers at from \$25 to \$250, and sold for one-third cash, and balance in one and two years. The contract binds the purchaser to plant shade trees within twelve months from date of purchase, and in nearly every town several lots have been sold and improved. The right of way and depot grounds have been obtained for the entire length of the road, the depot grounds at Omaha extended, and grounds for the government buildings and depot bought and assigned to General Myers, chief quartermaster, for that purpose.

A system of plats and records of the line, and the right of way, with an abstract of title, has been inaugurated, so that, at a glance, the company can obtain all the information they may desire on that score.

The surveys for bridging the Missouri river have been advanced, and, in separate reports, discussed. Mr. House has had charge of the office during my absence, and has discharged his duties to my satisfaction.

SURVEYS OF THOMAS H. BATES, DIVISION ENGINEER.

My instructions required that the surveys of Mr. Reed, in 1865, should be extended from Reed's Pass, in Humboldt Mountains, to the California State line. Mr. Bates was selected, in New York, for that duty, and reported to me in July. He immediately proceeded to Salt Lake and entered upon his duties. His very clear report sets forth the work performed by his party, and demonstrates that the Humboldt

and Truckee river valleys afford a feasible and most practicable line for a railroad over that portion of the country. The information obtained by Mr. Reed, in 1865, of the country west of Salt Lake, together with that obtained by Mr. Bates, in 1866, shows clearly that there is no great obstacle in the way from Salt Lake to California State line, no matter whether we choose the route north or south of the lake.

Mr. Bates's surveys give us, practically, a connected line from the Missouri river to the California State line. Mr. Bates's party run 371 miles of line, and the party had to march, to accomplish this and return to Salt Lake, about 1,000 miles.

They entered and developed a section of country that had never before been surveyed, and the discovery of Reed's Pass, in the Humboldt Mountains, in 1865, by Mr. Reed, has given us a line from Salt Lake west direct, with light work and comparatively easy grades. Ties for superstructure and timber for bridging this portion of the line can be obtained from Salt Lake and in the Sierra Nevada, with plenty of building stone along the route.

MR. VAN LENNEP'S (GEOLOGIST) REPORT.

The geology and mineralogy of the country, developed by the surveys during the year 1866, east of the Laramie plains, are ably set forth in the report of Mr. Van Lenep, geologist, who spent the entire season in that country with the parties, and devoted his whole time to this duty. The report is certainly a valuable one to the company and the country. It develops a region of country seldom examined, being too far north to have received much attention from the mining interests of Colorado, but which, I think, from this time forward, will draw the attention of miners and capitalists, and will disclose a mineral wealth heretofore considered improbable, the casual examination hitherto given it having always led to the conclusion that the mountains north of Thompson's creek or Cache La Poudre were hardly worth the time spent in prospecting. Iron, coal, copper, gypsum,

and building material for the construction of the road, certainly exist in great quantities, while the indications of silver and gold are such that I do not hesitate to predict rich mines and, hereafter, valuable discoveries in the immediate vicinity of the line.

The mountains south of the Laramie plains also contain minerals to a great extent, but as yet hardly developed, while the Wind river, Wasatch range, and Rush Valley mines, in Utah, indicate mines of great value in the vicinity of our surveys.

Mr. Bates's report develops fully the mining regions along the Humboldt Valley line, and it can be safely said that, after striking the Rocky Mountains, our line is in the vicinity of valuable mines until it strikes the California State line, crossing a succession of mountain ranges, all of which, it is fully demonstrated, are rich in coal, iron, copper, silver, and gold.

The surveys this year have connected our lines, settled the location over the first range of the Rocky Mountains, and given us the information, from that point to the California State line, that we have desired. The preliminary line ran has developed the country, shown us the obstacles we have to meet, what facilities the country will afford in material to build our road, the resources we may expect from it after being built, and demonstrated that a line can be built from the Missouri river to the California State line without meeting any mountain barriers, impassable snows, or great deserts that it is not practicable to overcome; that we have a line, for directness, distance, alignment, grades, and work, that is not equalled by any other road of the same length in the world. I claim that we have been highly successful in determining the general route of the road; that we have, in fact, the best general route across the continent. In the detail of location, and the selection of the best ground on the general route upon which to build the road, our time has been so limited that we have not been able to do justice to it; but, when it is remembered that we have all the time been in a hostile Indian country, unceasingly dependent upon military

escorts, every mile having been located under guard, without the ability of going beyond the range of musket, the party perpetually apprehensive of attack, it will be admitted that the engineers have performed their work much better than could have been expected.

The First Division, from the Missouri river to the mountains, is mostly in Platte or Lodge Pole valleys, crossing the Great plains, and affording but very little material for building the road. Ties for the first three hundred miles are taken from the Missouri river, and for the fourth and fifth hundred from 20 to 60 miles from the line. Stone exists only in limited quantities, and coal is not reached until we strike the mountains. Over this division we made our final settlement on line, and, for most of the distance, our final location.

The Mountain Division, from Crow creek to Salt Lake, covers the Black Hills range of the Rocky Mountains, the Laramie plains, the main range, near Bridger's Pass, and thence over the Wasatch to the Great Basin. Our difficulties here are in the Black Hills, Medicine Bow, and Wasatch range; but our preliminary line indicates that we shall overcome these mountain ranges without extraordinary expenses, with comparatively light grades, with but few miles of maximum grades, and with an alignment that is extraordinary, when we take into consideration the character of the country.

The surveys of the year 1867 will be devoted to an examination of this division in detail, and our location will be settled upon through it. Crossing the Black Hills we have plenty of timber—cedar, mountain pine, and hemlock. Rock in cuts, and adjacent to the line, exists in sufficient quantities for all building purposes, and the whole country is underlaid with valuable mines of silver, iron, copper, and gold.

After passing the Black Hills, we cross the Laramie plains, a broad park, 200 miles long in latitude, and 100 miles wide in longitude, shut in by the main range of the Rocky Mountains on the south and west, by the Sweetwater, and Black Hills on the north, and by the Black Hills range on the east, with the Rattlesnake range crossing it from

north to south, through its centre. It is watered by tributaries of the North Platte, and has a general elevation of 6,500 feet above the sea. The streams rise in the Medicine Bow Mountains, flow north, cutting this immense park at right angles, furnishing fair rafting streams to bring down to our line the immense bodies of timber on the north slope of the Rocky Mountains, which will build up a lumber trade that no one to-day can calculate the extent or value of.

Soon after striking the Laramie plains, coal begins to crop out, and it extends west, with few intervals, to Salt Lake. Sandstone and limestone exist in abundance. Material for building the road is of easy access to the line.

On the western side of this plain we pass the main range of the Rocky Mountains, about 7,200 feet above the level of the sea, 1,000 feet less than the elevation of Evans's Pass in the Black Hills, and enter the Bitter creek country, on the western slope of the Rocky Mountains, which is desolate, dreary, not susceptible of cultivation, and only portions of it fit for grazing. All of it is underlaid with immense beds of coal. Timber on this portion of the line, for 150 miles or more, is scarce, and the country has no inviting qualities.

After passing Green river we follow Black Fork some 80 miles, then commence raising the Wasatch Mountains, and, until the valley of Salt Lake is reached, we are in a mountainous country. Timber on this portion of the route abounds, coal is found, and there are indications of iron, silver, oil, &c.

This mountain range, although having at its western base the largest settlements of any of the Territories, in its mineral resources is but little known. The people in Utah are thrifty, have brought the available portions of the valley under cultivation, and have built up here, right in the heart of what was once considered a grand waste, known as the Great American Desert, a country and city that any State might be proud of.

Along this portion of the line material abounds of all kinds for the construction of the road. Produce for laborers

will be found in abundance, at fair prices, and within easy access, and labor to build this portion of the road exists there to-day, without importing a single man or mechanic.

The Pacific Division, from Salt Lake to the California State line, is divided, by the formation of the country, into two subdivisions, the first reaching from Salt Lake to Reed's Pass, in the Humboldt Mountains. This subdivision was examined on the line to the south of Salt Lake by Mr. Reed, in 1865. Its great objection is the desert, 42 miles long. The surveys indicated a practicable route, with easy grades and light work, but a great scarcity of water and timber. Examinations during the latter part of 1866 and the beginning of 1867 indicated a better route to the north of Salt Lake, crossing one arm of the lake, turning Promontory Point on the south, turning strongly north to Spring valley, thence west, skirting the northern rim of Great Desert or Mud Flats, passing through North Passes of Taone and Pequot Mountain ranges, and thence to Reed's Pass, in Humboldt Mountains. This route is shorter from the point where Weber river, Ogden river, or Bear river, debouches from the Wasatch range, than the route through Salt Lake city and south of the lake, avoids the desert, and places us in a country, a large portion of which is said to be fine grazing land, and a portion susceptible of cultivation, with a fair supply of water and timber, and, in grades, alignments, and cost, will compare favorably with the line south of the lake. It is also favorable for a branch to Idaho or Oregon via Pilot Springs and Raft river to Snake river. Which one of the two lines west of Salt Lake is adopted, our line will enter the valley of Salt Lake at such a point as to take advantage of either, without detriment to us or derangement to our present surveys or plans. Our surveys have also indicated a practicable route from Fort Bridger down Bear river to Salt Lake valley, or down Bear river to Soda Springs, thence across to Snake river, and down that valley, up one of its tributaries—Goose creek, or in that vicinity—to Thousand Springs valley, thence to Reed's Pass. This route is being examined. Its advantages are supposed to be the avoidance

of heavy grades and work, which we encounter in crossing the Wasatch range. In fact, this route turns that range to the north. Before a final location is decided upon this year, our surveys through this country, which were pushed all winter, will be before us, and will develop the main features of any line that can be got through that country.

From Reed's Pass to California State line, the second subdivision of the Pacific division, we are in the valley of the Humboldt to the sink, then cross to the Truckee valley, and follow that to the California State line, where we connect with the Central Pacific Railroad.

The Humboldt valley affords no timber, but plenty of all other building material. A large portion of it is susceptible of cultivation. The western portion is already taken up, and the line passes near the mining regions and cities of Nevada. It is direct; no grades to exceed 90 feet to the mile, and but few miles of that; by increasing the distance grades can be reduced to 50 feet per mile.

In thus briefly describing the general line of the road, I have paid no attention to the resources of the country, as relating to its future business; but every day demonstrates that, as far as built, *the road will pay*. The immense trade and traffic flowing to and from Nebraska, Colorado, Utah, Montana, Nevada, California, and the impetus it will give to the mining countries, as soon as it reaches there, no one can now estimate.

As a line, crossing the continent in the latitude it does, it has advantages possessed by no other line that has been or can be obtained; and it enters the heart of the best mining country yet developed, with superior advantages for building lines north to Montana, or northwest to Idaho or Oregon, south to Denver, and southwest to Pharanagat; to all these places are natural outlets from the main line, and valleys through which they can be reached, without meeting any of the great mountain barriers or deserts that the general topography of the country indicates, and which must be encountered in reaching these places on any other of the proposed routes across the continent.

During the year the work performed by the parties sums up as follows:

PARTY.	Lines. Instrumental.	Marches and reconnoisances.
Evans's party.....	623.6 miles.	956 miles.
Hills's party.....	623.5 miles.	750 miles.
Brown's party.....	500 miles.	850 miles.
Bates's party.....	371 miles.	1,000 miles.
House's party.....	100 miles.	200 miles.
Total.....	2,318.1 miles.	3,756 miles.

Making a total of 2,318.1 miles, instrumental lines, and 3,756 marches and reconnoisances, contained in a distance of 1,800 miles east and west, and 200 miles north and south. I do not hesitate to say, a very creditable showing in work performed and extent of country developed.

There are now built and running 305 miles of the road, commencing at the Missouri river and extending 10 miles west of the North Platte river. Of this distance, there has been built during the year 1866, between the 1st day of April and the 1st day of December, 254 miles; more road than was ever before built in the same length of time; and when we take into consideration the disadvantages under which the work was performed, with no railroad connection east, entirely dependent upon the Missouri river for our material, and upon the country for labor, with these obstacles to overcome, it challenges the attention of the world, and has drawn to it the eyes of the whole country.

The construction of the road has been under the direction of Mr. S. B. Reed, General Superintendent of Construction, assisted by Mr. Webster Snyder, General Freight Agent and Assistant Superintendent; and the corps of workmen, so well organized, and who have so faithfully performed the

duties, are entitled to the thanks of the company and of the country. The track-laying, under direction of Messrs. J. S. and D. T. Casement, reached as high as 3 miles per day, often 2, and averaged $1\frac{1}{2}$ mile per day for the days worked.

The track was faithfully laid, and well surfaced up as fast as the superstructure was put down, so that in two days after being laid down, cars ran smoothly over it at 30 to 40 miles per hour.

The road, in its grades, alignments, superstructure, stations, tanks, turnouts, and equipments, is a first-class American road. It has received the critical examination of the Government commissioners, on every section of 20 miles, as fast as built; and not one mile of it has been rejected as not coming fully up to the requirements of the law.

I desire to acknowledge my obligations to the military authorities for their uniform aid and interest in the road. They have been prompt to respond to all applications for escorts and protection, and have sent in charge of their troops, officers who held them under good discipline, and who were often of great aid to us in selecting camping grounds, guarding trains, stock, &c.

To Lieutenant General Sherman the company are especially indebted. He has taken great interest in the work, and has always instructed department commanders to give us all the aid in their power, consistent with their duties, and never to let the work stop or lag for want of military protection.

To General Cooke, commanding Department of the Platte; General Myers, Chief Quartermaster; Major Cushing, Chief C. S., and all the department staff, we are also indebted; and to Col. J. K. Mizner, commanding Fort McPherson, and Col. H. R. Mizner, commanding Fort Saunders; Major Kellogg, commanding Fort Morgan; Major Neil, commanding Fort Sedgwick; and commanding officers of Fort Laramie, I desire to tender the thanks of the company for the prompt and efficient manner in which they have always aided us. I have not the names of the commanders of our different escorts, but have heard my chiefs of parties speak in terms of

praise, without exception. With such cheerful aid from all the military, we cannot calculate the benefit it has been to us, the time it has saved, and the miles of unnecessary travel we have, through them, been able to obviate.

With Brevet Major-General C. C. Augur, commanding Department of the Platte, I have made arrangements for protection during the year 1867, and he has been very liberal, considering his means.

In submitting the reports of my chiefs of parties, I desire to call the attention of the company especially to the energy and perseverance with which all of them have performed their duty. Often threatened by Indian attacks, sometimes without escort, and obliged to examine the country alone, a portion of the time during the winter, they all have had narrow escapes, have had stock stolen, camps attacked, and been caught in heavy snow storms, in extreme cold, without fires; but, as yet, we have not lost any lives, or any stock of great value. In a country uninhabited, 100 to 1,000 miles away from any aid, and thrown upon their own resources, their positions have not been sinecures nor their responsibilities light. I have never given an order, no matter how difficult to perform, or what the obstacle to overcome, but they have all obeyed it with that energy and personal interest that only under such circumstances can bring success. The young men composing the parties are, as a general thing, far above the average, many of them of fine education, and who not only perform the duty well, but intelligently. To Messrs. Evans, Bates, and House, division engineers, and Messrs. Hills, Brown, Hodges, and O'Neil, assistant engineers, who have had charge of parties, I am under special obligations; also, to Mr. Van Lennep, the geologist. They are all to take the field for 1867.

I have submitted, from time to time, maps and profiles of parts of the line. I now submit profiles of all the line not heretofore sent you; also, maps of lines west of Salt Lake, and a general map attached to this report, showing all the lines run during the year 1866, and those run heretofore,

making a connection from the Missouri river to the Pacific ocean.

Tables of grades, altitudes and distances are also attached, which will be of value for future reference. The grades on the preliminary line will be materially reduced in final location.

I am, very respectfully,

Your obedient servant,

G. M. DODGE,

Chief Engineer.

Table of Grades, U. P. R. R., Omaha to California, 1867.

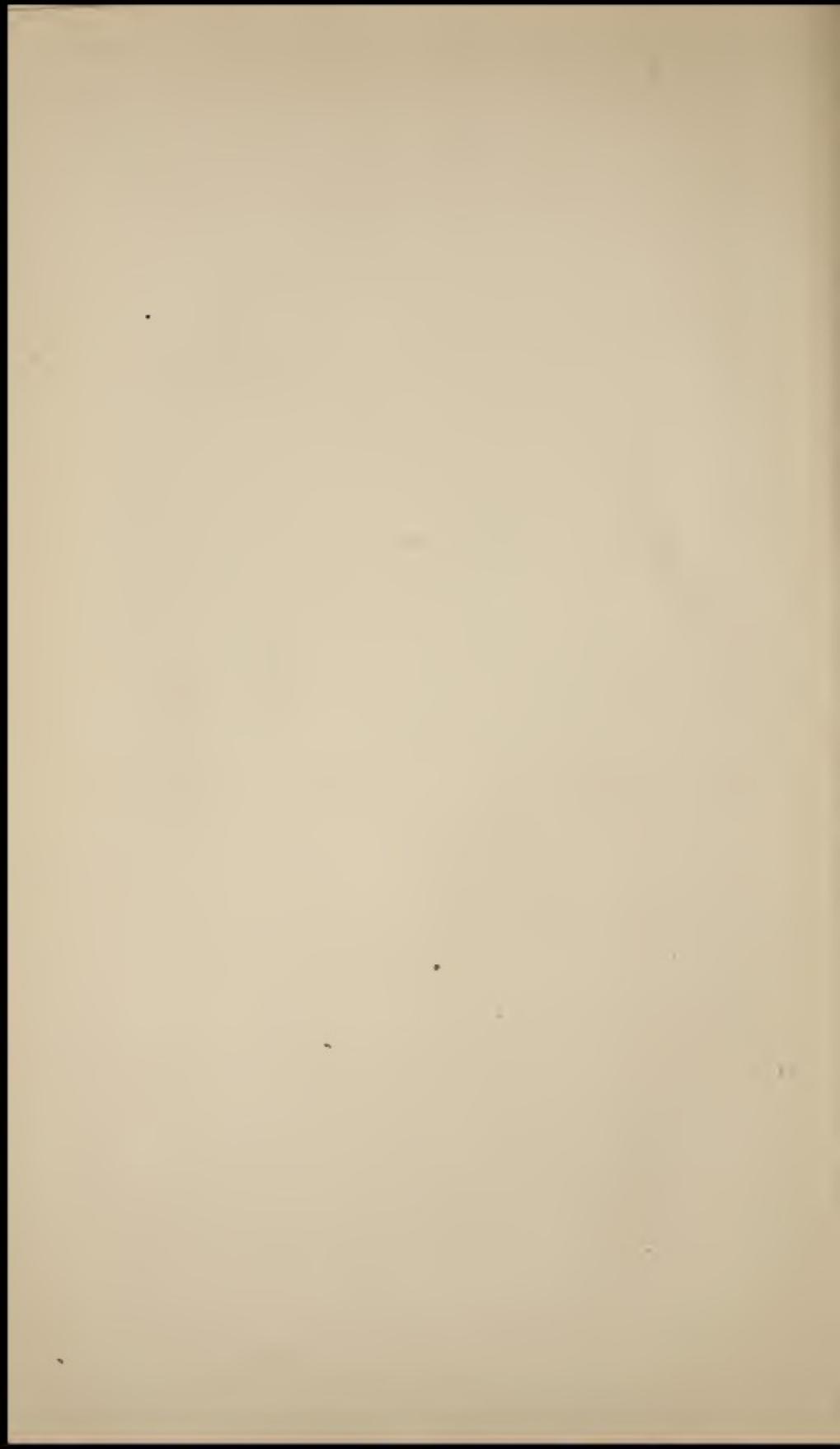
Level, Miles.	0' to 20' per m.		20' to 40' per m.		40' to 60' per m.		60' to 80' per m.		80' to 100' per m.		100' to 110' per m.		Length, Miles.	Asc. in feet.	Des. in feet.	
	Mi. asc.	Mi. des.	Mi. asc.	Mi. des.	Mi. asc.	Mi. des.	Mi. asc.	Mi. des.	Mi. asc.	Mi. des.	Mi. asc.	Mi. des.				
First 100 miles.....	30.32	52.14	1.38	6.44	6.23	.....	2.82	0.76	.....	.....	.....	.....	100.09	797	289	
Second 100 miles....	20.99	63.61	4.96	6.88	.57	.....	.....	.....	.....	.....	.....	.....	100.01	746	60	
Third 100 miles.....	19.43	63.47	6.63	8.12	2.36	.....	.....	.....	.....	.....	.....	.....	100.01	790	103	
Fourth 100, to mouth Lodge Pole.....	9.08	45.53	6.99	12.90	1.84	.....	.....	.....	.....	.....	.....	.....	76.34	780	122	
Mouth Lodge Pole to Crow creek cross to	20.20	37.12	3.68	61.26	4.17	9.52	1.36	.....	.....	.....	.....	.....	137.31	2682	169	
Crow creek cross to Laramie river....	7.49	51	2.61	1.42	4.33	5.91	1.64	9.00	3.91	13.54	7.27	.....	57.63	2285	1129	
Laramie river to Green river.....	31.81	21.53	53.14	17.88	17.84	21.53	16.17	15.19	16.26	8.82	5.23	3.00	12.55	240.96	3733	4774
Green river to Salt Lake City.....	26.50	34.20	25.62	19.05	41.19	7.12	19.00	8.90	9.43	1.08	4.68	7.76	9.89	214.42	2880	4729
S. Lake City to Desert Across Desert.....	17.79	20.96	18.99	4.49	3.44	3.54	0.45	1.67	0.95	0.42	0.28	0.38	0.72	74.08	684	434
West side of Desert to Reed's Pass.....	20.00	5	6	16.00	14	5	10	12	8	3	7	4	6	116.00	2492	1410
Reed's Pass to Califor- nia line.....	3.80	8.52	10.64	4.17	10.30	0.66	2.27	.....	1.42	.....	0.85	.....	.....	42.63	231	708
	65.39	38.60	141.93	42.34	50.08	6.33	1.02	7.43	3.37	2.92	0.57	0.95	2.10	363.03	3093	3448
														1622.50	20192	15655

Note.—In location, all grades can be brought to a maximum of 90 feet to a mile.

On Humboldt river valley, grades, by following river or cañon, can be reduced to maximum of 80 feet to a mile.

Table of Altitudes and Distances, U. P. R. R., Omaha City to California Line.

	Distance.	Altitude.
Missouri river at Omaha—initial point of first hundred....	0.00	968
Omaha summit, elev. grade.....	4 17	1191
Elkhorn summit.....	28.97	1191
Elkhorn river, surface of water at crossing.....	30.49	1191
North Platte, surface of water at crossing.....	290 53	2790
Station 4034, near mouth of Lodge Pole.....	376.95	3528
Lodge Pole creek junction, station 5575.....	484.75	5262
Crow creek crossing.....	513.76	6019
Evans's Pass.....	545.62	8248
Laramie river junction.....	571.39	7175
Green river, mouth of Bitter creek.....	812.34	6315
Summit between Black's Fork and Green river.....	820.00	6464
Water in Black's Fork, 2 miles below mouth of Muddy creek.....	858.00	6375
Summit between Muddy creek and Bear river.....	893.00	7567
Surface of water in Bear river.....	926.00	7015
Summit at head of Echo cañon.....	959.00	5535
Mouth of Weber cañon.....	995.00	4655
Salt Lake City.....	1026.76	4285
Desert, east side.....	1100.84	4600
Desert, west side.....	1176.00	4700
Gooshoot Pass.....		6030
Reed's Pass of Humboldt Mountains.....	1259.47	5550
State line of California—terminal point.....	1622.50	5195



REPORT OF JAMES A. EVANS,

(DIVISION ENGINEER.)

UNION PACIFIC RAILROAD,
ENGINEER'S OFFICE, OMAHA, N. T., Dec. 31, 1866.

To General G. M. DODGE,
Chief Engineer.

SIR: I have the pleasure of submitting the following report of explorations and examinations made by the parties under my charge during the year 1866.

Under the direction of Mr. Durant, V. P., I organized a party, with P. T. Brown as principal assistant, and proceeded immediately to Fort Kearney, where I joined the party and run lines A, B, C, D, and E, as follows:

Line A. From station 9590 of located line, crossing the Platte river near Fort Kearney, and running southeasterly, by way of Spring creek, to the Republican Fork. This, with slight modification, is substantially the line of 1865.

Line B. From the Platte river, near the mouth of Plum creek, to an intersection with line A, and thence to the Republican *via* Spring creek, one line being common to both in the valley of that tributary.

Line C. From the end of the second hundred miles, direction southeasterly, crossing both branches of the Little Blue river, and connecting with the Republi-

can valley line of the Kansas branch at station 1925 of that line.

Line D. From Platte river, near Plum creek, to an intersection with the line of 1865 in the valley of Deer creek, direction southeasterly, connecting with the line of the Kansas branch at station 3335 of that line.

Line E. Same as line D, with the difference that it avoids the valley of Deer creek, keeping on the divide to the east of it, and from its grades being less favorable than line D.

Gradients and distances will compare as follows:

	Length of Line.	Maximum Grades.
Line A.....	50.98 miles.	84.48 feet per mile.
Line B	34.60 miles.	84.48 feet per mile.
Line C	57.11 miles.	45.7 feet per mile.
Line D.....	51.59 miles.	40.0 feet per mile.
Line E ...	51.23 miles.	65.9 feet per mile.

In addition to the line run, the country between the Platte and Republican rivers was very thoroughly examined, sufficiently to make evident the superiority of lines C and D, the one running in a southeasterly, the other in a southwesterly direction.

While at Fort Kearney, engaged in shaping the notes of the lines last referred to, I received telegraphic instructions from you to transfer the party to Mr. Brown, and await the arrival of a party then in process of organization at Omaha, with the further intimation that instructions would be furnished for my guidance in the future. The further movements of the party used on the foregoing surveys will therefore be found in Mr. Brown's report.

The party organized at Omaha arrived at Fort Kearney on the 8th of June. A few days prior to their arrival I received by mail the following instructions :

“U. P. R. R. COMPANY,
“CHIEF ENGINEER’S OFFICE, OMAHA, NEB., May, 1866.

“To JAS. A. EVANS,

“*Division Engineer U. P. R. R.*

“DEAR SIR: With the party that will join you from here, you will proceed to Fort Sedgwick, connect with your line near that fort, and run a line up Lodge Pole creek to Cheyenne Pass, connecting with the line through that pass. You will then proceed to give that portion of the Black Hills (that you have not already thoroughly examined and demonstrated beyond doubt the practicability or impracticability of a line over or through them) a critical examination from Cache la Poudre to and including Laramie cañon. A line must be got through Laramie cañon. The men can pack through, or you can run from each end and connect. Any way to get a line through and give us its topography, levels, &c. You know a railroad can be built where a mule or man can hardly travel.

“I would suggest, as a base for the examination of the Black Hills, that you travel along the crest, taking elevations by barometer or otherwise, and when any approach to them, or depression in them, indicates that a road can be got through, that you run a line through, connecting on the east with a line along the base, or directly with your Cache la Poudre or Lodge Pole creek lines, and west with a line at the base of the hill, or your line through Laramie plains. The lines at the base are to keep connection of surveys, and to give us the topography, approaches, and distances.

“If a favorable line can be got through the Laramie cañon, we can undoubtedly run nearly west and cross the Rocky Mountains between Bridger’s and South Pass, or can go down

Rock creek or the Medicine Bow river to the Sweetwater river, and up that.

" You will see that we are anxious to determine beyond a doubt where we shall pass the Black Hills. That is really our first objective point, as it fixes our line east and west. We desire to determine this as early as possible, so that the line we decide upon can be located through the Black Hills this fall, and, if we so decide, made ready for this winter's work. Unfortunately for me, in giving these instructions, I have not your reports, maps, and profiles of the Black Hills before me, and have never seen them. I cannot, therefore, base these instructions upon them, or make any suggestions as to particular lines.

" I also desire, before the party returns, that the country south of Cache la Poudre, to where the South Platte enters the mountains south of Denver, should be examined, and lines run through any passes that may indicate that they are feasible. After Mr. Brown gets to Denver, his party can be used for this purpose. This, however, must not interfere with your work north of the Cache la Poudre.

" As fast as a line is run, I desire the profile, preliminary report, and rough-map notes, so that we can make a map from them here, and get the information before us as fast as possible.

" I also want to hear from you as often as possible. Write freely, making such suggestions as your knowledge, already obtained, and which you may develop in future surveys, may seem to you best. What we want is, a direct practicable line through the Black Hills as soon as possible, with the further knowledge that it is the best and most feasible one that can be got, so that, after we have decided upon it, and commenced work, no other practicable line shall be discovered that we have not ourselves examined.

" In making your examinations, I desire you to collect specimens that will determine the geology, mineralogy, and the mineral and agricultural resources of the country; also, to note freely the timber, stone, coal, and everything that

will aid us in building and running the road. Specimens collected will be labelled where found, and brought in on your return, or sent in before opportunity offers.

"I need not impress upon you that time in these matters is everything with us, and that the limited season that we can work in should be every moment improved. Use economy in all expenses.

"Information obtained in the country by the engineering party is for the use of the company only.

"Very respectfully,

"Your obedient servant,

"(Signed)

G. M. DODGE,

"*Chief Engineer.*"

Compliance with the foregoing brought me to Julesburg on the 15th of June, at which place I commenced the line to Camp Walbach, up the valley of Lodge Pole creek. The total length of this line, from station 9078 of the Platte valley line of 1865, near Julesburg, to station O of the survey of 1864, at Camp Walbach, is 159.65 miles. As a portion of this survey has become since a located line, forming a part of the fifth hundred miles, I shall not here, while treating of preliminary lines only, attempt to give any tables of grades.

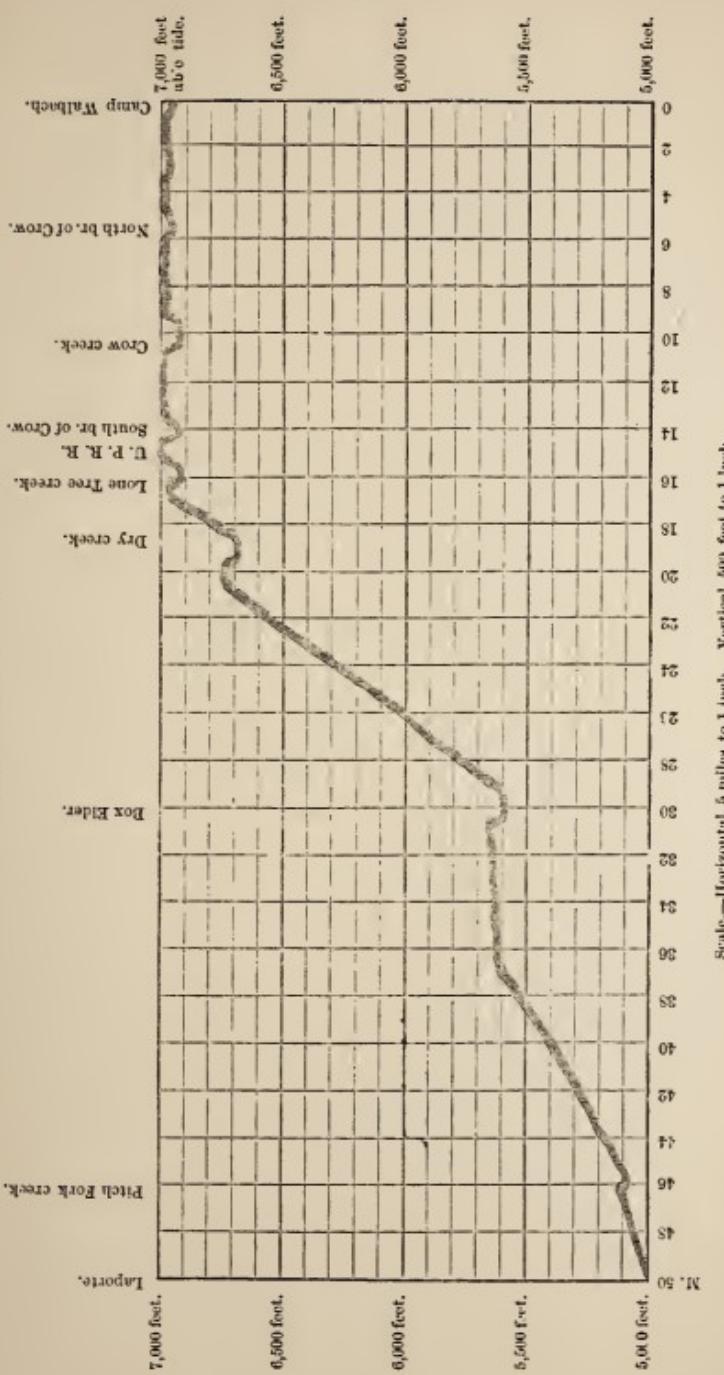
On making connection at Camp Walbach with the survey of 1864, I started, from that intersection, a base line along the eastern foot of the Black Hills, running south. This base line is continued to the table land south of the Box Elder creek, distant from its zero at Camp Walbach 35 miles. While making this examination, the fact was elicited that the elevation at the base of the range was kept up from the Lodge Pole creek across all the tributaries of Crow creek, and as far as the divide separating the latter stream from Lone Tree creek. From thence the country drops off rapidly in a southern direction as far as the Cache la Poudre, there being a difference of 2,000 feet between La Porte and either

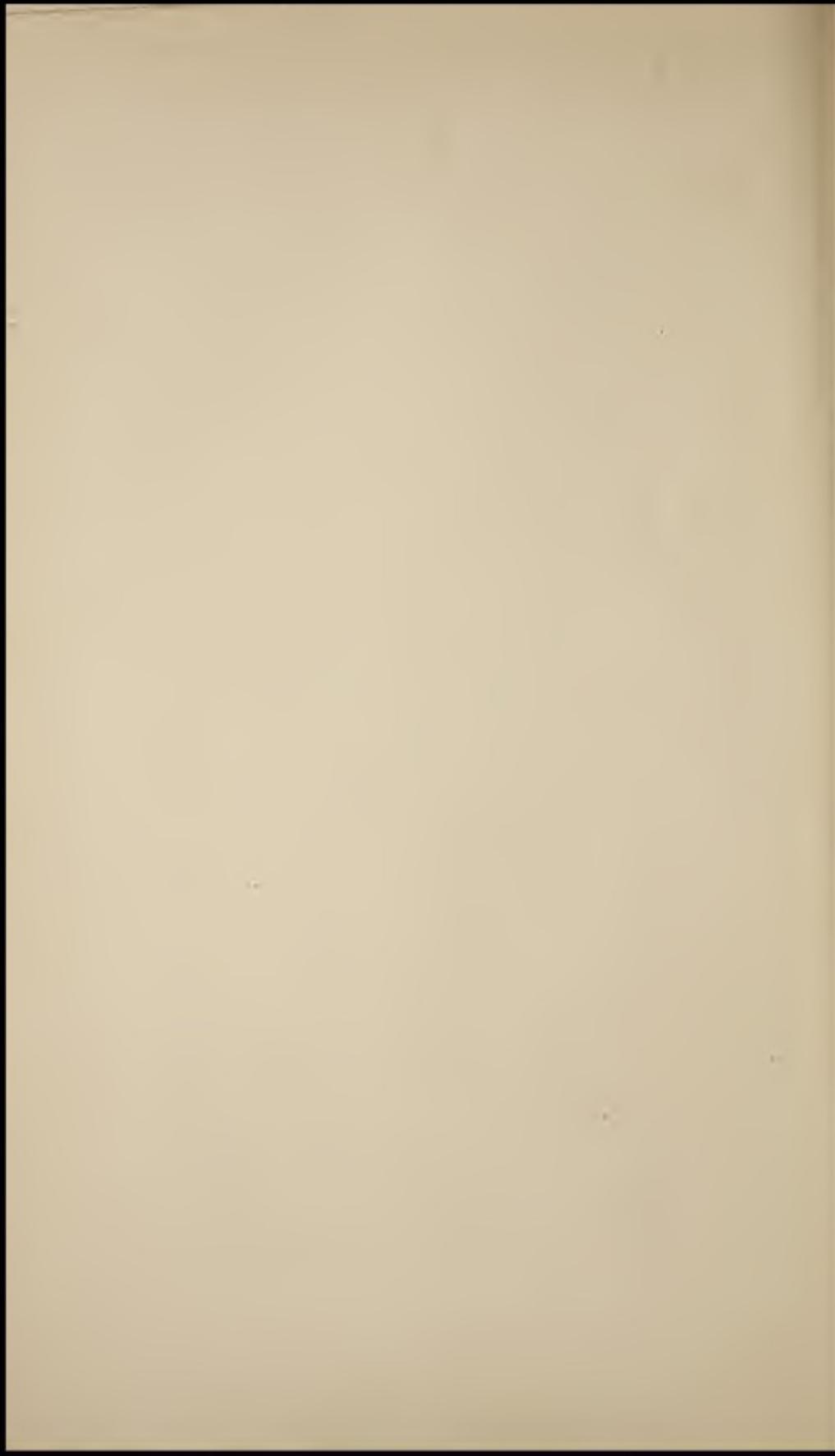
Camp Walbach or the divides between the tributaries of the Crow and the Lone Tree.

The following condensed profile of the country between Camp Walbach and the Cache la Poudre is submitted:

PROFILE.

31





While making this examination along the eastern slope, it became evident that if we could maintain our elevation, (knowing the height of the summit,) there was distance enough to carry us over, with reasonable grades, as, starting with an elevation of 7,000 feet, we could avail ourselves of a summit 400 feet lower than at the head of the Cheyenne Pass, and at the same time maintain the comparative shortness of the line over that depression. The only difficulties seemed to be: First, carrying our line over the stratified rocks and on to the granite, as in almost every instance lateral ravines of considerable depth occurred when the formations came together. After running a number of trial lines, the divide between Lone Tree creek and the South Branch of Crow creek was fixed upon as the one promising the best crossing, for the reason that there the connection between the sandstone and the older rocks was preserved by a neck of land forming a continuation of the divide, enabling us to reach the summit without undulating grades. After ascertaining the feasibility of pushing our line west, there only remained, Secondly, the question of being able to cross the valley of Crow creek and make a suitable connection with our line on the Lodge Pole, to make this a desirable line from Fort Sedgwick (Julesburg) to Laramie plains.

While doing this work, I was, unfortunately, deprived of the assistance of Mr. O'Niell my first assistant, by an accident while in the discharge of his duty. It resulted in his being absent from the party some six weeks, during which time such lines were carried across the Black Hills, connecting with lines previously run, as demonstrated fully the practicability of this crossing of the range.

The completion of the line across the Black Hills found the party on the Laramie plains, and as an instrumental examination of the Laramie cañon was required by my instructions, it seemed best to proceed with it then, although it would necessitate a postponement of the connection of the last and best crossing of the range with the line east, in the valley of Lodge Pole creek.

This was done by taking up our line of 1865 near the

crossing of the Big Laramie river, and running a base line on the west side of the Black Hills to the point where the Laramie river enters the cañon, between which points nothing worthy of note occurs. Knowing the country on the east side of the Black Hills, north of Camp Walbach, it was quite evident that nothing would be developed by running over the crest. At the risk of a little repetition, I may state here, that from Camp Walbach north, the country descends rapidly, as well as south. This descent is carried by the valley of the Chugwater as far as Fort Laramie. The actual instrumental examination of the gorge more than confirms my impressions from a reconnaissance made in 1864, and set forth on page 20 of my report for that year. The descent of the stream itself, from the upper end of the cañon to where it debouches on the plains east of the Black Hills, is as follows:

TABLE.

From Station.	To' Station.	Miles.	Grade per mile.	From Station.	To Station.	Miles.	Grade per mile.
0	106	2.07	47.0	606	661	1.04	78.0
106	158	1.00	60.0	661	713	1.00	46.0
158	216	1.1	62.0	713	769	1.07	78.0
216	270	1.02	58.0	769	804	0.6	75.0
270	330	1.15	45.0	804	892	1.66	135.0
330	382	1.0	62.0	892	1014	2.31	115.0
382	434	1.0	39.0	1014	1076	1.17	157.0
434	502	1.27	12.0	1076	1122	0.87	80.0
502	554	1.00	60.0	1122	1286	3.2	107.0
554	606	1.00	105.0	1286	.....	.....	.....

The total distance through the cañon is 24.71 miles. In this distance eight tunnels, of the aggregate length of $1\frac{8}{10}$

mile, would be necessary, and 3,000 feet of truss-bridging, with curves of minimum radius of 716 feet. The accompanying map will at once determine the character of the gorge. Could no better crossing of the range be found than this, and should the building of a line through it become imperative, the winter snows would certainly make it impassable for traffic.

After completing the line through the cañon, finding it necessary to proceed to Fort Laramie for supplies, on returning, I thought it prudent to run a line from that fort to the mouth of the cañon, thinking, if any examinations were made up the valley of the north fork of the Platte river, it would be the means of connecting all our surveys, and would, at the same time, show the approaches to the Laramie cañon. This line was, of course, carried up the valley of the Laramie river, 42 miles being the distance from the flag-staff at the fort to the mouth of the gorge. This distance will require 12 truss-bridges, each of two spans of 150 feet. Aside from that, the work would be comparatively light.

This work being completed, I moved the party and transportation to the southward, along the base of the hills, and *via* the valley of the Chugwater, for the purpose of completing the connection with the Lodge Pole creek line, producing the line easterly from the Crow creek and Lone Tree creek divide, across the former stream, and over the divide between Crow and Lodge Pole creeks, into the valley of the latter. This connection was found more favorable than I anticipated. Although there is but a single preliminary line over the divide, I feel confident in the assurance that no grade need be used from the valley of Lodge Pole creek, going west as far as the crossing of Crow creek, exceeding 35 feet per mile, maximum.

Aside from the eastern connection last mentioned, a line was run from the crossing of Crow creek, down the valley of that stream, to an intersection with the line of 1865, in the valley of the south fork of the Platte river. This line, in consequence of the easting made by Crow creek in its

course, was found much longer than was supposed from the course of the tributary, as laid down on the Government maps.

While at La Porte, after examining with you the several crossings over the Black Hills, I received the following letter of instructions:

“LA PORTE, COLORADO, October 9, 1866.

“JAS. A. EVANS, Esq.,

“Division Engineer U. P. R. R.

“DEAR SIR: As soon as practicable, you will extend the new Crow creek line to the junction with Lodge Pole creek; then commence the location of the new Crow creek line, in Crow creek valley, and locate west, over the Black Hills, as far as weather will permit. Having examined the preliminary lines with you, and given my views as to the changes to be tried, it will not be necessary for me to mention them in detail.

“The location will be made with a maximum grade not to exceed 90 feet per mile, and as short a distance of that as the ground will admit, and maximum curvature not to exceed 8° per 100 feet. When the weather closes in, so that it is impracticable to keep the party in the field, you will return to Omaha, to make up your report of summer work, placing your party in winter quarters on Dale creek, under Mr. O'Neill. They will put up a comfortable log house for themselves and stock, using all fair days during the winter in running preliminary lines over the different crossings of Dale creek, through the gorge, and along the crags at the forks, and such other lines as you may deem best, in order to give us a full knowledge of all crossings and approaches to Laramie plains. They will carefully cross-section the line located, and the most favorable preliminary line from the sunmit to Laramie plains, provided you should not be able to terminate the location to the plain.

“During the winter, an accurate daily record of the climate, weather, winds, fall of rain and snows, will be kept. Also, you will note carefully the rise and fall of the streams

in the Black Hills, and all other information that will be of service to us in locating, building, and running the road.

"On returning to Omaha, bring with you all notes, leaving a copy of such as will be needed by the party in the Black Hills. That party will remit by mail note of lines as run, as often as practicable, that we may work it up in the office during the winter.

"Hay and corn may be purchased for the stock, but the feed on the Dale creek is such that stock should do well, if the winter is open, without much grain. I want the stock to come out in good condition early in the spring.

"Arms and ammunition for the party can be obtained of Col. Mizner, at Fort Sanders.

"If any portion of the party conclude to return to the States, they can be sent in by one of the teams.

"I am, respectfully,

"Your obedient servant,

"(Signed)

G. M. DODGE,

"Chief Engineer."

The foregoing instructions were carried out while I remained with the party, so far as to make the connection with the Lodge Pole creek line, (which, in a foregoing paragraph, has been referred to,) and the location carried west from Crow creek towards the summit, a distance of 14 miles. The weather then becoming stormy, I judged it advisable that winter quarters should be prepared immediately, and such advantage be then taken of fair days as would enable us to locate approximately, in the office at Omaha, the line over the range. Giving the necessary instructions, I came to Omaha by way of Denver. Up to the date of this report, everything contained in the foregoing instructions has been complied with, (with the single exception of a preliminary line north of our camp on Dale creek, enough of which has been sent in to demonstrate its impracticability.) The grades are within the maximum given, and the curvature much less. The line is approximately located on paper, in such a way as will enable us to do the field work very rapidly, making

such modifications as a close examination of the ground may suggest.

The line up Lodge Pole creek, over the divide between it and Crow creek, thence up the divide between Crow creek and Lone Tree to Evans's Pass, being the one finally adopted by the company, I will give the grades necessary, note some of the peculiarities of the route, and, at the same time, give such information as I have been able to obtain on that part of the line extending from Julesburg to the crossing of the Laramie river.

Tables of grades will be found in the Appendix, marked "B."

The alignment for the entire distance is superior. The minimum radius required is 1,146 feet, and that but in a single instance. From the crossing of Crow creek to the Laramie river, the amount of curvature will not exceed 20 per cent. of the entire distance. My past experience in mountain work leads me to consider this as extremely favorable.

From the crossing of Crow creek, going west, the line follows a tributary of that stream for 10 miles nearly; from thence it is on the divide or ridge between Lone Tree creek and the south branch of Crow creek. This will give great freedom from snow obstructions, and but little annoyance in operating the road will be met with in this particular. Occupying the highest ground in the vicinity, as the located line will from necessity do, but little mechanical work is required. Aside from the truss-bridging over a tributary of Lone Tree and Dale creeks, the amount of provision for water-courses is astonishingly small for a mountain district.

Building stone, for what structures will be required, is abundant and convenient. It can, in every instance, between the points named, be obtained from cuttings adjacent to the bridges and culverts.

Material suitable for the manufacture of lime can be obtained at a sufficient number of points to meet all the wants of construction.

Water-stations along the route from Julesburg can be

located when required, and water obtained without difficulty. Only on the divide between Lodge Pole and Crow creeks will deep digging be necessary to obtain it.

TIMBER AND FUEL.

Taking up the line at Julesburg, and proceeding westerly up the Lodge Pole, the first timber suitable for cross-ties and bridging that may be considered contiguous to the line occurs about 58 miles up Lodge Pole creek, and distant from it from 15 to 25 miles to the northward. Since the establishment of Fort Sedgwick, (Julesburg,) that post has been principally supplied with fuel from thence. It occurs on Laurens Fork and its tributaries, an affluent of the North Platte. From parties familiar with this locality, I am led to believe that 100,000 ties may be obtained here. Mr. P. T. Browne, who made the location up the Lodge Pole, visited this district, under instructions from you, and will be able to corroborate my views with reference to this matter.

If this estimate should prove correct, sufficient tie-timber can be obtained from thence to lay the iron from where they would conveniently be brought to the line with the least haulage, to where our located line leaves the valley of Lodge Pole creek. Before reaching that point, however, the line passes Pine Bluffs. Here, in gulches stretching north and south, at right angles with the line, and along the bluffs, a scant growth of pine is found. It may be possible, by hauling, at the extreme, 12 miles, to obtain 15,000 or 20,000 more. The timber is very scattering, and the obtaining of them would, for that reason, be attended with considerable expense; but as this is the best timber found on the line east of the Black Hills, and as at this point we are distant from timber between 50 and 60 miles, there seems to be a necessity for using them.

In the Black Hills the timber generally occurs north of the line. The most extensive timber tract (as I have had occasion to notice heretofore in my reports) is on the summit, where the Lodge Pole, Crow, and Dale creeks have their rise.

This timber is distant from the line, at Evans's Pass, from 10 to 12 miles. It might be brought down the divide to the line at that point, delivered conveniently at the crossing of Dale creek, and likewise hauled down the western slope, striking the line some four miles back of the crossing of the Big Laramie river. The timber east of the summit is confined to the margin of the water-courses, tributaries of Crow and Lone Tree creeks.

The timber tracts next in importance to the one noticed above, occur in gulches on the western slope, distant from the line on the Laramie plains six to nine miles, the material from which would conveniently find its way to the line on the plains at the foot of the western slope.

No outcroppings of coal have been found on the line between Julesburg and the Laramie river. South of the line, on the tributaries of Crow creek, Lone Tree, and the Cache la Poudre river, abundant outcroppings have been discovered, leading to the supposition that the part of the line east of the Black Hills and west of where we leave the Lodge Pole creek is underlaid with a deposit of coal.

Mr. Van Lennep, who accompanied me as assistant in the party, and incidentally as geologist of the expedition, and to whom I was able to give all facilities for making examinations in this matter, will report to you. You are respectfully referred to his report for further information.

IRON.

Nodules of this mineral are abundant in the drift east and west of the Black Hills. In 1864, while proceeding down the Chug Water, I found, where the Laramie road strikes that stream, nodules of what seemed to me a very rich magnetic ore of iron, some of which were brought back on the completion of the survey. They were so abundant in and contiguous to the stream as to show unmistakably a large deposit in the vicinity.

During the survey of this season I resolved to investigate the matter further. Starting from Camp Walbach, in com-

pany with Mr. Van Lennep, and taking up the trail on the Chug Water, we succeeded in finding the bed some 15 miles from where the water-washed nodules were first discovered. It occurs in a massive formation in the primary rocks. It may be stated to be inexhaustible. It is certainly rich in iron, and unless its chemical constituents are such as to interfere with its reduction, it cannot be otherwise than valuable. I take it for granted that Mr. Van Lennep will give further information about it, and trust that a proper analysis will be made of it, to fully determine its character.

Although it occurs in the eastern slope of the Black Hills, the most convenient and likewise the most economical way of taking it to the line would be over the summit and to the Laramie plains. I think that geological examinations west of the Laramie river will show the existence of coal there in sufficient quantity for smelting purposes.

I would respectfully suggest that some means be taken to fully develop the geology of the country from the Laramie river west, more particularly the valleys of Rock creek, Medicine Bow, and North Platte. I am of the opinion that discoveries of coal of sufficient importance can be made through that region to amply repay the cost of the examination. To be efficient, this should be done by some one having the matter solely in charge, and entirely free from duties connected with the party. Sufficient outcroppings are found to furnish a starting-point for an intelligent examination.

This seems the more necessary from the probability that our line may be at a greater distance from the supply of timber in the Medicine Bow mountain than our present preliminary; and as the question of fuel must have a bearing upon the final location, there seems to be a necessity for such information during the coming season.

I beg to refer to the location of that part of the line between the valleys of Lodge Pole and Crow creeks, over the divide between the streams. The line should be north of our present preliminary, thereby avoiding the break leading into the Muddy Fork of Lodge Pole creek. Upon reaching

the margin of the valley of Crow creek, the line should hug the slope, continuing northward, making the crossing of Crow creek north of the present one, and yet not so far north but that we can continue the line west up the valley of the tributary we are now in. The above will enable us to avoid, in a great measure, the undulations of grade in the valley of Crow creek, and further enable us to make the distance between Lodge Pole creek and Crow creek with a maximum grade, ascending west, of 35 feet per mile. This line will prove both cheaper and better than a corresponding distance in the valley of Lodge Pole creek.

Profiles have been furnished of all lines run.

The crossing of the Black Hills being now finally fixed as far as the Laramie river, there remains only the making of the final location. Our notes and knowledge of the country are such as to enable us to do this rapidly. As soon as the weather will permit, the preparations for construction can be soon completed.

Respectfully submitted.

JAS. A. EVANS,
Division Engineer.

APPENDIX.

Table of Distances.

	Miles.
Omaha to Julesburg.....	375.10
Julesburg to station 5575 of preliminary line.....	107.17
Station 5575 to Crow creek crossing.....	31.79
Crow creek crossing to summit of Evans's Pass.....	31.66
Summit to Laramie plains, station 2590.....	12.21
Station 2590, on Laramie plains, to Laramie river.....	15.20
Total miles.....	573.13

The amount of labor performed by the party under my immediate charge may be summed up thus: Lines actually run, 623.6 miles; marches, independent of the above, 956.0 miles.

TABLE OF GRADES.—B.

ASCENDING.

DESCENDING.

	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.
0 to 20 ft. per mile.	20 to 35 ft. per mile.	35 to 60 ft. per mile.	60 to 80 ft. per mile.	80 to 90 ft. per mile.	0 to 20 ft. per mile.	20 to 40 ft. per mile.	40 to 60 ft. per mile.	60 to 80 ft. per mile.	80 to 90 ft. per mile.
Julesburg to station 5575 of Lodge Pole creek line.....	46.91	53.01	0.19	.....	100.11	4.03	3.03	.....	.....
Station 5375 to Crow creek crossing.....	4.06	19.84	.....	.....	24.00	.....	6.29	.....	1.50
Crow creek crossing to sumt of Evans's Pass.	1.30	1.57	6.59	8.8	13.4	31.66	.....	.....	.....
Summit of Evans's Pass to Laramie plains....	.....	.....	.....	.....	.....	2.71	0.87	2.	3.13
Laramie plains to cross- ing of Laramie river.	.....	.....	0.30	.....	.....	0.30	8.12	2.44	1.16
Distances.....	52.27	74.42	7.08	8.8	13.4	156.07	14.86	12.63	3.16
									5.02
									5.84
									41.96

Total distance, 198.03 miles.

METEOROLOGICAL NOTES,

Taken by Mr. W. McLain, of the party at Dale Creek Camp, in November, 1866.

Day.	Thermometer in open air. Mean of 3 obs.	Rain.	Snow in inches.	REMARKS.
1	61°			
2	57°			
3	63°			
4	59°			
5	61°			
6	60°			
7	60°			
8	53°			
9	45°			
10	37°			
11	31°			
12	30°		2.5	
13	32°			
14	31°			
15	33°			
16	45°			
17	42°			
18	39°		1.5	
19	45°			
20	49°			
21	46°			
22	36°			
23	38°			
24	33°			
25	33°			
26	28°		1.5	
27	19°			
28	23°		1.5	
29	18°			
30	23°			
Mean for month	41 9-10°		7.0	

During the month the winds have been as follows:
W. and N. W., 17 days.
North, 2 days.
East and S. E., 4 days.
Southwest, 7 days.

METEOROLOGICAL NOTES.

December, 1866.

Day.	Thermometer in open air. Mean of 3 obs.	Rain.	Depth of snow in inches.	REMARKS.
1	31°			
2	32°	.....	0.25	
3	29°	.....	0.5	
4	26°			
5	25°	.....	4.5	
6	35°			
7	30°			
8	9°	.....	6.0	
9	4°	.....	2.0	
10	14°			
11	24°			
12	37°			
13	31°			
14	37°			
15	25°			
16	20°			
17	24°			
18	25°			
19	32°			
20	31°			
21	39°			
22	23°	.....	6.0	" (Signed) W. McLAIN."
23	20°			
24	21°			Prevailing winds for month—
25	25°			W. and N. W., 27 days.
26	28°			N. and N. E., 2 days.
27	33°			E. and S. E., 2 days.
28	32°	.....	4.5	
29	20°	.....	2.0	
30	9°			
31	9°	.....	3.0	
Mean for month,	24 8-10°	.....	28.75	

REPORT OF P. T. BROWNE,

(PRINCIPAL ASSISTANT ENGINEER.)

ENGINEER'S OFFICE, OMAHA, *Feb'y 20, 1867.*

General G. M. DODGE,

Chief Engineer:

SIR: The surveys completed by the engineering party, of which I have been in charge during the year 1866, have comprised preliminary lines:

1. By the Republican valley to Fort Morgan, on the Platte.
2. From the mouth of Bijou creek, *via* the Platte valley, to Denver.
3. Denver to Middle Park, *via* Clear creek and Berthoud Pass.
4. From Middle Park through Boulder Pass.
5. A location line from the mouth of Pole creek to the Crow creek divide line of 1866.

Besides the instrumental work, reconnoisances of the country near the lines, and of the mountain passes leading from Clear creek, have been made.

The work was commenced June 2, 1866, with the

REPUBLICAN LINE.

Starting near the head of Spring creek, at a point on the Fort Kearney and Republican line of 1865, 31.58 miles from Fort Kearney, and continuing that line southwesterly to the valley of the Republican river; thence up the valley, on the

north side, to Arickary Fork; up Arickary to Rock creek, and along its valley to the table-land south of the Platte, looking to the Platte valley, near Fort Morgan, as an objective point.

The line from Spring creek enters the Republican valley near its most northerly bend, and crosses in its course a succession of creeks, separated by divides 70 feet to 140 feet high, that run nearly at right angles to the line, and that cause deep cuts, high banks, and heavy grades to be necessary.

A road for this distance, 16.5 miles, would require 1,096 feet of bridging and 9.5 miles of maximum grade.

There are 94 miles of the line in the valley of the Republican, which is from one to two and a half miles wide, with bluffs 50 feet to 100 feet high bordering it. The bluffs have short, steep slopes to the bottom-land, and are frequently washed by the river. The bottom on the north side is wider than that on the south, with not as many bluff-crossings.

Before reaching the Frenchman's Fork, 71.6 miles from the starting point, the line crosses twenty streams, emptying into the Republican and draining the country north nearly to the Platte, the divide between the Republican and Platte being near the latter stream, and the valley of the Republican 150 feet lower than the valley of the Platte. Most of these creeks will require truss-bridges. Between the Frenchman and the Arickary there are but few creeks, and all are of a small size. For crossing Frenchman's Fork, 200 feet of truss-bridging and 200 feet of trestle would be required.

The grade of that portion of the line in the Republican valley does not exceed 40 feet per mile, except where the river washes the bluffs, and where the grade is 66 feet per mile. The average grade of the valley is from 8 to 9 feet per mile.

Arickary Fork is the principal branch of the Republican, the river for 5 miles west of their junction (as far as explored) being dry. The valley is narrower than that of the Republican, and the stream more crooked. We were obliged to cross to the south side 12.5 miles from its mouth, and

then carry the line over a broken table, there being no bottom-land. The principal bridges are those spanning the Arickary, the first of 300 feet and the second of 200 feet. This valley rises 12 feet per mile, with no grade exceeding 50 feet per mile.

Rock creek joins the Arickary 23.2 miles up the stream, and is the larger, there being no running water in the Arickary west of their junction. The creek is 31 miles long. The table-land in the valley of Rock creek is rough, and the valley narrows rapidly near the head, the creek running across from bluff to bluff. The valley rises 20 feet per mile, with maximum grades of 68 feet per mile.

From the head of Rock creek west to the ridge of which Fremont's Butte is the culminating point, a distance of 30 miles, the table is broken by sand ridges and hills, high and numerous near Rock creek, the Buttes, and the Platte, but separated by valleys running northwest and southeast at points between them. The table, west of Fremont's Butte, to the breaks of the tributaries of Beaver creek, is smooth, with a gravelly soil. Between Rock creek and Beaver creek there is no water.

On reaching the head of Rock creek we left our transportation and escort at the last water, camping one night in the sand hills without them, and continuing the line next day till overtaken by the train, which left the creek early in the morning. We then started for the nearest point of the Platte, reaching it at dark of the second day, our mules and horses very much exhausted by the long drive through the sand and abstinence from water.

On arriving at Fort Morgan we obtained barrels for the transportation of water. We started at station 4034 of Cache la Poudre and Platte valley line, a mile east of the mouth of Bijou creek, and worked east to the line from Rock creek, finding water in pools in the channel of Beaver creek, from which the line party was supplied by teams belonging to the escort, the command being encamped by the pools during our operations on the dry divide.

The distance from the initial point at Spring creek to station 4034 of the Platte line is 251.4 miles.

The distance from Fort Kearney to Fort Morgan—

By the Platte line,	288.45 miles.
By the Republican line,	289.83 miles.

By passing through a gap in the range of sand hills, 3 miles north of our present line, and 5 miles south of Fremont's Butte, and then running west to a tributary of Beaver creek, and down its valley, and that of Beaver creek, to the Platte, the heavy grades on the divide between Beaver creek and the Dry creek west would be avoided, and the distance to the mouth of the Bijou shortened about 5 miles.

The scarcity of water prevented a reconnoisance of the country before the route was selected.

From Spring creek to the Frenchman there is sufficient timber on the Republican and its tributaries for the construction and maintenance of a road for that distance. West of the Frenchman there is little timber on the Republican, and from the Arickary to the Platte none at all.

The land in the valley of the Republican, as far west as Frenchman Fork, is of good quality, and can, I think, be cultivated without irrigation. West of the Frenchman the soil gradually grows thin and poor to the sand hills, where the ground is covered by cactus and sand weeds.

A poor quality of limestone is abundant from Spring creek to the head of Rock creek, occurring in horizontal layers that crop out in the bluffs on the Republican, and that crown the bluffs with layers below on the south side of Rock creek, sand hills bordering the valley on the north side.

A compact variety of sandstone was found on a branch of Beaver creek, 18 miles from the Platte.

No coal or ores were met with.

PLATTE VALLEY.

The Platte line was begun where the line of 1865 crossed the river 5 miles west of Fort Morgan, and follows the south side of the Platte to Denver. The distance from Fort Mor-

gan to Denver is 98.6 miles; Fort Morgan to Latham, at the mouth of the Cache la Poudre, 47.6 miles; Latham to Denver, 51 miles.

Between Fort Morgan and Latham there are three bluffs to cross, with grades of 70 feet to 116 feet per mile, and three creeks, requiring bridges, emptying into the Platte, on the south side. No sharper curve than three degrees will be required.

From Latham to Denver, the valley on the east side is wide, with but little water, draining into the river, and but one small creek to cross; while the north side is broken, the river near the bluffs, and the tributaries draining the country to the summit of the mountains more numerous.

The grades are very uniform, and on locating, many of the undulations in the present profile can be thrown out without much increase of curvature.

The majority of the curves would be of 11460 feet radius, and none of them of a less radius than 5730 feet.

TABLE OF GRADES.

Bijou Creek to Latham.

Miles. Ascending.	Grade per mile.	Miles. Descending.
3.314	Level.	
23.656	0 feet to 20 feet.	1.610
4.375	20 feet to 40 feet:	1.965
0.758	40 feet to 60 feet.	0.170
1.193	60 feet to 80 feet.	1.287
0.359	80 feet to 100 feet.	0.549
.625	100 feet to 116 feet.	0.454
34.280		6.035

Whole distance, 40.315 miles.

GRADES.

Latham to Denver.

Miles. Ascending.	Grade per mile.	Miles. Descending.
3,826	Level.	
12,633	0 feet to 10 feet.	0.341
22,443	10 feet to 20 feet.	1.004
5,170	20 feet to 30 feet.	0.985
4,545	30 feet to 40 feet.	.
48,617		2.330

From Fort Morgan to Latham there is little land that can be irrigated, the bottoms being narrow and the bluffs broken and sandy; but between Latham and Denver, the entire valley can be irrigated and excellent crops produced.

West of Latham there is a thin growth of cottonwood, but none below that point.

Compact and durable sandstones and limestones crop out in the bluffs, and are easily quarried in blocks 8 feet to 16 feet thick.

BERTHOUD PASS SURVEY.

An experimental line was carried from Denver to Golden City, connecting, at the mouth of Clear creek cañon, with the line run for the Colorado Central Railroad Company, from Golden City to Central City, *via* the main and north branch of Clear creek.

The notes of this survey, as far as they could be available, from Golden City to the mouth of Clear creek, were used by us, having been furnished by W. H. A. Loveland, Esq., the

vice-president of the company, to whom we are much indebted for this and various other acts of courtesy.

The connecting line leaves the Platte valley opposite Denver, and continues on the prairie $9\frac{1}{2}$ miles, when the valley of Clear creek is entered and followed to Golden City. The grades are heavy. By keeping on the slope of the bluffs bordering the valley of the Platte to Clear creek valley, the distance would be increased 4 miles, descending grades avoided, and all brought within the maximum.

A better line would be found by leaving the Platte line at the mouth of Clear creek, 5 miles below Denver, crossing the Platte there, and following the valley of Clear creek.

Clear creek cañons for the $15\frac{1}{2}$ miles previous to its exit from the mountains. The channel is crooked, sides steep, and, in many places, precipitous, and cut up by deep gorges where the lateral branches come in. The creek falls 1,544 feet in $15\frac{1}{2}$ miles, giving an average grade of 98 feet per mile. By keeping on the mountain side, with heavy work, sufficient elevation can be gained, where the descent is light, to overcome the falls and rapids within the maximum grade.

A line could be located through this cañon, with no grade exceeding the maximum or curve sharper than 12° ; $9\frac{1}{2}$ miles of curve, with a total deflection of 4662° ; 6.1 miles of straight line; 4,975 feet of tunnelling; 900 feet of truss-bridging; about 190,000 cubic yards of rock excavation, excluding tunnelling; 160,000 cubic yards loose rock excavation; and 50,000 cubic yards earth excavation.

From the head of the cañon to the South Fork the valley is wide, creek straighter, mountain sides rounded, and the grade from 60 feet to 95 feet per mile.

Above the forks the stream falls rapidly, in some places 300 feet per mile. To overcome this elevation, and be enabled to reach the Berthoud Pass, the line was carried up the South Fork 4 miles; thence back along the steep slope of the mountains, with a maximum grade, to a depression or pass in the divide between the South Fork and Bard creek; through this pass, with a tunnel 575 feet long, and again on the mountain side, continuing the maximum grade,

till the bottom of the valley was reached, 1.8 miles west of the pass, then back to the entrance of the tunnel at the pass.

THE BERTHOUD PASS

is a depression in the range on the north side of Clear creek. Hoop's creek, a small branch of Clear creek, heads on the south side, and Moses creek, flowing *via* James river to the Grand, on the north. The elevation of the summit, which is below the line of arborescence, is 6,124 feet above the Platte river, at the upper bridge in Denver, and 11,304 feet above the level of the sea. The direction of the pass is nearly north and south.

The tunnel would enter the mountains at station 2304, 1,364 feet below the summit, and, with a uniformly ascending grade of 26.4 feet per mile, would be 16,400 feet, or 3.1 miles long.

From the north end of the tunnel the line follows, for 11.5 miles, with a maximum descending grade, the northeast side of the spur of the mountains dividing Moses and Dennies creeks, to the head of the Park, where the line was discontinued.

The grade of the Park, for 5 miles below the junction of Moses and Dennies creeks, is 75 feet per mile.

The whole amount of truss-bridging between Golden City and the Park would be 4,445 feet, and of tunneling, 4.2 miles.

While in the mountains we were accompanied by Mr. E. Berthoud, civil engineer, the discoverer of the Berthoud Pass. Mr. Berthoud possesses a thorough knowledge of the country, and rendered us great assistance in our surveys and explorations.

TABLE OF GRADES.

Denver to Middle Park.

Miles, Ascending.	Grade per mile.	Miles, Descending.
2.197	Level.	
1.382	0 feet to 20 feet.	0.947
7.027	20 feet to 40 feet.	1.458
3.371	40 feet to 60 feet.	0.190
6.382	60 feet to 80 feet.	0.757
4.336	80 feet to 100 feet.	0.663
32.478	100 feet to 116 feet.	11.500
57.173		15.515

Total distance, 72688 miles.

Iron, coal, lime, and fire-clay are found in abundance at Golden City; pine and spruce timber near the line at the lower end, and fir near the summit of the range.

The rock of all the cuttings would be some variety of granite.

As far as I could learn from settlers on the east side, there will be no serious difficulty from snow east of Bard creek. From Bard creek to the summit snow lies from 3 feet to 5 feet deep in winter, and drifts badly.

On the west side of the mountains storms are more frequent and the snow deeper, and, the line being on the north slope, the snow would not melt till June.

While at work on the west side, near Boulder Pass, September 15th, snow fell to a depth of 2 feet, with drifts 6 feet deep on the slope and much deeper in the ravines. The grass was covered, and, having no grain, we were obliged to feed our rations to the mules and horses, and work our way to the east side to save the party.

Boulder Pass is 11,700 feet above the sea. The eastern approach is short and steep. Our line was carried 6 miles from the summit on the east side, with a descent of 2,870 feet. By using all the distance that could be gained by running up the branches of Boulder creek, a maximum grade would enter the mountain 20,000 feet from the summit, making a tunnel 31,200 feet or 5.99 miles long.

The passes leading from Clear creek, that were examined, are—

1. Argentine Pass, at the head of Leavenworth creek, a branch of the South Fork, and leading to Snake river on the west.
2. Quail Pass, at the head of Quail creek, also a branch of the South Fork.
3. Jones Pass, at the source of the middle branch of the North Fork of main Clear creek.
4. Vasques Pass, 4 miles west of Berthoud, from the west side of which Dennies creek flows.
5. Berthoud Pass.
6. A pass at the head of Fall river.

Argentine is the highest of these passes, and Berthoud the lowest, as well as the only one that can be reached by a grade of 116 feet per mile.

POLE CREEK.

A line was located up the valley of Pole creek to the intersection of the divide line from the base of the mountains. Distance 106 miles. The connection at the east end was made in the Platte valley at station 4033 of the fourth hundred miles. The creek annually overflows its banks and covers all the adjacent bottoms, compelling us to keep on the tables, and at every creek crossing to raise the grade from 12 to 19 feet above the ordinary surface of the water. The alignment is good, there being but two curves of 3820 feet radius, and five curves of 5730 feet radius, the remainder being of a radius of 11460 feet.

TABLE OF GRADES.

Pole Creek.

Miles, Ascending.	Grade per mile.	Miles, Descending.
18.428	Level.	
5.985	0 feet to 10 feet.	0.568
20.361	10 feet to 20 feet.	2.613
54.091	20 feet to 30 feet.	3.864
98.863		7.045

There is no timber in the valley of Pole creek. One hundred miles up the stream there is a range of bluffs on which there is a thin growth of pine.

While the party were at work on the location, I spent three days in exploring the Laurens Fork of the North Platte and its tributaries. Leaving Pole creek 75 miles from its mouth, a ride of 15 miles brought me to the nearest branch of the Fork. On this, the South Branch, there can be cut 10,000 ties and 2,000 cords of wood. The valley is half a mile wide, with steep limestone bluffs on either side, through which the small creeks have cut deep gorges. On the sides of the bluffs and in the cañons the pine is found. The channel was dry except at two places, where a little water appeared at the surface; but wood-cutters say that water can be found anywhere in the creek by digging.

Five miles further north is the main branch of Laurens Fork. The valley is 5 miles wide, with bluffs and cañons similar to those on the South Branch. The stream itself is about the size of Pole creek, with running water as far as followed it. About 2,000 ties can be obtained from each lineal mile of the stream.

There is plenty of poor limestone in Pole creek valley, but I could find none fit for masonry.

The soil is dry, and often sandy, but I should judge there was sufficient water in the creek, at ordinary stages, to irrigate the whole valley.

The location of the Pole creek line was finished December 10th, our party having, since the 2d of June, ran more than 500 miles of line, nearly 100 miles of which were over the roughest kind of mountain country, and 106 miles a location line.

During my frequent absences, owing to the necessary exploration, &c., Mr. F. E. Appleton remained in charge of the party, a gentleman in whose judgment, ability, and regard for the interests of the company, I have the highest confidence.

Very respectfully,

I remain, yours, &c.,

P. T. BROWNE,
Principal Assistant Engineer.

REPORT OF L. L. HILLS,

(ASSISTANT ENGINEER.)

OMAHA, Feb. 13, 1867.

To General G. M. DODGE,

Chief Engineer U. P. R. R.:

I have the honor to report, that on the 27th day of June, 1866, I was left in charge of the locating party by the resignation of D. H. Ainsworth.

We had just completed the location of the third 100 miles of the U. P. R. R., which location was made on the north side of the Platte river, and ended 1,780 feet north of the proposed crossing of the North Platte river.

On the 6th of July I received orders to make other crossings, to find, if possible, better direction, and, at the same time, a favorable point for locating a bridge. The river, at this time, was at its flood height, and remained so for about three weeks. Through the kindness of Major Norton, then commanding the post at Fort McPherson, we were supplied with a boat. Upon examining the ground, I found that the most favorable point for leaving the line of location made by Mr. Ainsworth was at station 4692 of the third 100. The distance across the river, by triangulation, is 2,107 feet; total curvature, $85^{\circ} 16'$, for both sides of the river. The water at this place was about 10 feet deep in the channel, and at the highest stage of water.

Another crossing was made by leaving the line of location at station 4933+36. The distance across the channel at this place was 2,042 feet; total curvature, $76^{\circ} 41'$.

The crossing made by continuing Mr. Ainsworth's location was found to be 1,295 feet across the channel, with a total curvature of $210^{\circ} 40'$.

The approach to the river, on the north side, (on this last-mentioned crossing,) is over low, wet, marshy ground for 6,000 feet. The line by this crossing is 14,958 feet longer than the crossing made from station 4692, equal to 2.83 miles.

The middle crossing was 4,644 feet longer than the lower crossing.

The river was measured in other places, but none were as favorable as those mentioned. (The lower crossing has since been adopted.)

While these lines were being run, our team was at Fort Kearney after supplies, which, by an accident to the ferry-boat, 12 miles above Kearney, were lost in the Platte river. There was but little saved. This accident caused some delay in the work.

On the 26th day of July, the escort under Lieut. Hughes came to us. On the 27th we completed all the connections of the different lines, from all of the crossings, and were fairly under way with the fourth 100.

On the right of about station 500, of the fourth 100, the rock begins to crop out of the sides of the bluffs. It is a soft sandstone, and is found in layers of from 3 inches to 4 feet in thickness. It is underlaid by sand and clay, which crumbles easily. The rock is not suitable for heavy masonry. It will answer for culverts or open bridges. The quality improves and the quantity increases further to the west.

On the first 50 miles of the fourth 100 miles there is no place where stone would have to be hauled more than 5 miles for culverts and bridges. Most of the way it would not require more than one mile of hauling.

We did not encounter any engineering difficulties on the fourth 100 other than the *swells* which put down from the bluffs. These swells extend so far out into the valley that it necessitates short, heavy grades, or a line following the bends of the river.

After getting through the first location of the fourth 100, which was the shortest practicable line that could be had, we returned, according to instructions, to the beginning of the second 20 miles of the fourth 100, and re-run 60 miles, cutting out much undulating ground, and improving the grades all the way through. The last location was longer than the first by 3,300 feet. In getting good grades, we could not avoid alkali grounds. The average rise per mile on the fourth 100 is 8.22 feet. The line crosses the Lodge Pole creek at 379.3 miles from Omaha. The swells from the bluffs give out west of the Lodge Pole, and the ground is quite uniform in its slope from the foot of the bluff to the bank of the river.

Near the west end of the fourth 100 there is an abundance of good rock in the bluffs, 2,000 feet to the right of the line. There is not timber enough along the whole length of the fourth 100 to make a respectable camp-fire. We got wood from Ash Hollow and from Fort Sedgwick.

The grading of the fourth 100 will be generally easy. There is no rock-cutting on the fourth or fifth 100 in the Platte valley location.

We got a good line on the fifth 100, as far as to station 3880, the only exception being opposite Godfrey's Ranch, where there is about 8,000 feet of heavy work. The average rise per mile is 8.41 feet, as far as we went.

There is but little land along the valley of the Platte which is considered valuable, except for cutting hay. The alkali increases rather than diminishes, as far up as Fremont's Orchard. The quality of the grass in the valley and in the bluffs is better near the foot of the mountains. A few attempts at raising vegetables have been made in the Platte valley, but with poor success. Whether the failure was the result of the want of proper care, or from the peculiar qualities of the soil, I do not know, but I am inclined to credit the latter.

There is water at the heads of nearly all the streams that put into the Platte, but no running water, for most of the year, at their mouths. The same cause operates with

the small side streams as with the great system of drainage from the eastern slope of the Rocky Mountains. The underground currents carry off the water, except when these channels are overcrowded by spring floods, and it finally makes its appearance in the Platte and Republican rivers hundreds of miles from where it started.

On the 2d of October I received orders to "run a preliminary line up Pawnee creek, and across the divide into Crow creek valley, and connect with Mr. Evans's line in that valley." I called upon the oldest inhabitants of the Platte valley, near the mouth of Pawnee creek, and got information, which I found to be *incorrect* in almost every particular.

From the Platte valley line to the summit of the divide between Pawnee and Crow creeks, the distance is 49 miles; in which distance the rise is 1,284 feet, an average of 26.2 feet to the mile. From the summit toward Crow creek the ground descends at the rate of 30 feet to the mile, for 8 miles, from which point the ground again rises at the rate of 15 feet per mile to the intersection with the Crow creek line. The distance from Platte valley to this intersection is $61\frac{1}{2}$ miles. I found it quite impracticable to cross the divide farther to the north, or to connect with Mr. Evans's line, farther to the west, on favorable terms.

A good spring of water was found on the summit of the divide. There are considerable quantities of timber in and about the south end of the White Bluffs. It is a mixture of pine and cedar, mostly pine. I did not discover any traces of coal on Pawnee creek. The rock in the bed of the creek is a solid mass of slate, soft and scaly.

After making this connection with the Crow creek line, I made a reconnoisance of the country to the southwest, and found that it was impracticable to get a line directly across the country toward the mouth of the Cache la Poudre. We continued the Pawnee creek line up the valley of Crow creek, and made another intersection at the foot of the White Bluffs, that lie between Crow and Lone Tree creeks. Our second intersection was at station 2165 of Mr. Evans's line, making the whole distance from the Platte valley line,

by the Pawnee creek line, 76.25 miles. The elevation here is 4,457 feet above datum line.

From this point we commenced again, making station 2165 of Crow creek line sta. 0 for new line. We followed around foot of the bluffs toward the valley of Lone Tree creek. The country, at best, is very bad, and quite impracticable, except at enormous expense and with heavy grades. The streams which have their heads in these bluffs run southeast into Crow creek.

These bluffs, like those at the head of Pawnee creek, are composed of white clay and sand intermixed, with strata of sandstone.

After rounding the bluffs, we found it necessary to keep on the divide between Crow and Lone Tree creeks for about 18 miles, before getting down into the valley of Lone Tree. After getting into the valley, we found good ground to the mouth of the Cache la Poudre. Of this line, station 2814+84=1610+54 of Brown's Cache la Poudre line. The distance from station 2165 of Crow creek line to this point is 53 3-10 miles.

As soon as the necessary arrangements could be made, we started again to explore the valley of Lone Tree creek. We made station 1950 of the line that we had run down the starting point for a line to run up the valley. We found a good line up to a point where it is necessary to turn out of the valley of Lone Tree to get into the valley of Crow creek. It is quite impossible to find any divide that can be followed from any point on Lone Tree to Crow creek. The country is badly broken, and the divides give out sooner than the valleys.

We intersected with Evans's located line west of Crow creek crossing, at station 340+65, making the distance from Cache la Poudre line to this intersection 53.25 miles. So that, by lines already run, the distance from Denver to "Crow creek crossing" is about 112 miles, with a good, practicable line.

We made another connection $3\frac{1}{2}$ miles farther west, but not as good as the one mentioned. We ran still another

line, farther to the southwest, up one of the southern branches of Lone Tree creek. Annexed is a table of grades from Denver to Crow creek line.

The line to Denver would of necessity run near to the mouth of the Cache la Poudre.

The coal and iron beds which lie near the base of the mountains can be better reached from the north side of the Platte. Those beds now being worked are on the branches of St. Vrain and Clear creeks.

The Denver branch should cross the Cache la Poudre about 2 miles west of its junction with the Platte, and run up on the north side, crossing the Big Thompson, St. Vrain, and Clear creeks, which are the only streams of importance emptying into the Platte from the north side between the Cache la Poudre and Denver. By being on the north side better connections can be made with the mining territory of the mountainous districts.

A branch could be run up the valley of the St. Vrain to the coal and iron beds, or up Clear creek to Golden City. Either of these lines would be easily built, as there are no engineering difficulties to overcome.

A railroad to Golden City would, in time, be of far more value to the company than one to Denver, for the simple reason that it would get the business nearer to headquarters by 15 miles.

If simply a connection with Denver is all that is desired, it would seem best to cross the Platte below the mouth of the Cache la Poudre, thus throwing all the bridges into one.

The advantages of being on the north side more than overbalance the disadvantages of construction. It is hardly possible to get a practicable line nearer to the base of the mountains than the valley of the Platte.

Between Lone Tree and the foot of the Black Hills there is but one stream of any importance, and that is the Box Elder. This stream empties into the Cache la Poudre about 8 miles east of La Porte.

There has been a coal bed opened on a small creek which has its source between Lone Tree and Box Elder. This

bank is 10 or 12 miles north of the Cache la Poudre, and about 8 miles from the valley of Lone Tree creek. A line could be thrown to within about 4 miles of this bank, and get as good profile and alignment as on the present line.

We can get through that country, north of the Cache la Poudre, on lines parallel to the streams, but when we attempt to get from one stream to another we find heavy work as well as heavy grades.

We found traces of iron in the valley of Lone Tree which seem to give evidence of extensive beds of ore.

The magnetic variation on Crow creek is $15^{\circ} 21'$ east.

The party under Mr. Ainsworth located the third 100 miles, which, added to what we located afterwards, made 273.5 miles of *line located*, beside re-running 200 miles of *re-locating* line. Add to this 250 miles of *preliminary* line, and the total is 723.5 miles, from the 1st of June to the 1st of December.

Our transportation was often insufficient, owing to the scarcity of wood, which had to be hauled from where it could be found.

I take pleasure in stating that the men who composed the party did their work cheerfully, and with an ability unequalled by inexperienced men.

There was but little sickness in the party.

Messrs. Fergason, Eddy, Chas. and Geo. Bent, are particularly deserving of credit for the prompt and efficient manner in which they responded to the duties devolving upon them, and I take pleasure in recommending them to special notice.

RECAPITULATION.

Located by party,	273.5 miles.
Re-run on location,	200 "
	<hr/>
	473.5 "
Preliminary line run, including set-backs and lines re-run,	250 "
	<hr/>
Total,	723.5 "
Average rise per mile on third 100,	6.89 feet.
Average rise per mile on fourth 100,	8.22 "
Average rise per mile on fifth 100,	8.41 "

I am, very respectfully,

Your obedient servant,

L. L. HILLS,
Assistant Engineer U. P. R. R.

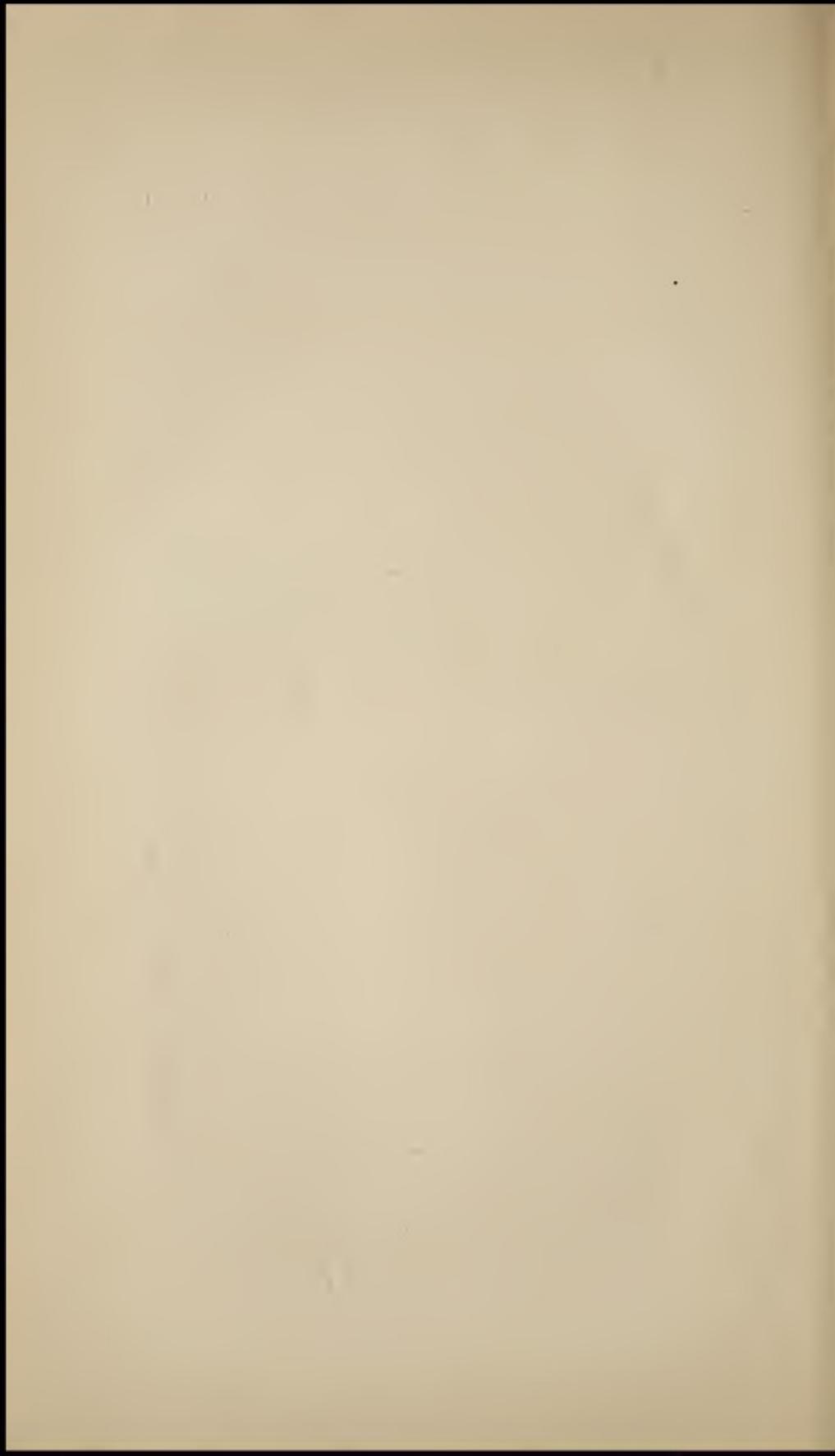
Table of Grades for Lines run for Union Pacific Railroad Company, for 1866, by Hills.

Names of Lines.	Ascending Grades.						Descending Grades.							
	Level.	0 to 10	10 to 20	20 to 30	30 to 40	40 to 50	50 to 60	0 to 10	10 to 20	20 to 30	30 to 40	40 to 50	50 to 60	60 to 70	70 to 80
*Third 100 miles located up the Platte valley.....	19.03	38.26	24.52	8.19	1.50	.....	.....	4.64	0.90	2.95				
+Fourth 100 miles located up the Platte valley.....	9.05	34.00	31.72	20.22	.....	.....	.....	3.00	2.65	2.46				
†Fifth 100 miles located up the Platte valley, 73.5 miles.....	7.79	40.00	18.68	5.00	.....	.....	.....	0.47	1.00	0.75				
Pawnee creek line, from Platte valley to Crow creek.....	1.20	.....	12.80	38.20	.....	13.00	.....	0.70	.....	3.30	7.30			
Line from Crow creek to Lone Tree creek valley.....	.....	.....	.....	1.30	2.50	3.70	2.50	.....	.....	1.30	18.00	.....	7.60	1.00
Lone Tree creek line, from 340+65 of Crow creek located line to Cache la Poudre.....	.....	.....	3.00	.....	.....	.....	.....	.....	16.20	10.70	9.10	7.60	5.70	
Line from Cache la Poudre to Denver, by P.T. Browne 1866.	5.30	17.57	21.75	7.95	.....	.....	.....	.....	.....	0.38	2.18			
Total miles.....	41.37	132.83	109.45	80.86	4.00	16.70	2.50	8.81	21.13	23.64	34.40	7.60	13.30	1.00

*Average for third 100 miles in feet, 6.69.

†Average for fourth 100 miles in feet, 8.22.

‡Average for fifth 100 miles in feet, 6.41.



REPORT OF J. H. HOUSE,

(DIVISION ENGINEER.)

ENGINEER'S OFFICE, OMAHA, April 1, 1867.

General G. M. DODGE,

Chief Engineer Union Pacific Railroad:

SIR: I have the honor to submit the following report of surveys, embracing the hydrographic survey of the Missouri river, the location of the second hundred miles, the laying out of towns, right of way, and the Omaha office.

HYDROGRAPHIC SURVEY.

On reporting to Mr. D. H. Ainsworth, engineer in charge, on the 8th day of January, 1866, I was ordered to make a full and complete survey of the Missouri river, from the mouth of the Platte river, in Sarpy county, to Rockport, in Washington county, Nebraska; to run a line on both shores, connecting with the Government surveys where it was possible to do so.

I organized a party and commenced survey at once. On the 16th day of the month, other duties calling me away temporarily, Mr. F. H. Case, division engineer, was placed in charge of the party, he continuing surveys until about the 1st of March, having meandered both sides of the river between the points designated, and also had soundings and cross-sections taken about every 2,000 feet. The ice in the river becoming unsafe, it was found that they could not be taken oftener, and insure complete soundings of the whole

line. I resumed further surveys of the river in April, having, in the meantime, located the second 100 miles.

Lines were run from various points on the river, where there might be any possibility of crossing by means of a high or low bridge, and profiles of the same are herewith submitted.

LOCATION OF THE SECOND 100 MILES.

It being deemed expedient and advisable to change the location of the second 100 miles, by keeping nearer the Platte river and avoiding the increased drainage, which is evidently greater, the valley being lower in the vicinity of the bluffs than near the river, I was ordered, on the 5th day of February, 1866, to make the changes of location, and immediately organized a party and proceeded to Wood river, to determine the crossing of that stream, and the practicability of a tangent from the end of the first 100 to that point.

I commenced survey on the 12th day of February, by running temporary lines east from Wood river to intersection of the located line. Snow having fallen, on the night of the 11th, to the depth of one foot, and the long, dried grass of the valley being still on the ground, made the walking very laborious. The intersection was made at station 5300, on Saturday, the 17th, having been detained nearly two days by one of the severest snow storms I ever witnessed.

On the following Monday I started location from station 5300. The weather for the last few days having been mild and pleasant, the snow had nearly disappeared. Although the country presents such a flat appearance, with no marked drainage, there was but little trace of water left in the valley. The soil being sandy and very porous, absorbed it as rapidly as melted, showing conclusively that our road-bed, by being elevated about two feet on an average, would always be dry and out of the way of surface-water and snows.

From all the information I could get from the "oldest inhabitant," I was led to believe that the Platte river never

gorged above the mouth of Loup Fork, and was never known to overflow its banks in extreme high water; consequently, low grades were adopted the entire length.

The weather being very fine, and the frost disappearing from the ground, we were enabled to progress rapidly with the survey, making from 8 to 10 miles per day. Our first line, ending at station 9965, was finished on the 5th day of March.

Thinking the line might be improved from Grand Island settlement to the Wood river table, thereby avoiding Warm Slough, and a shorter line obtained by keeping farther to the north, I returned with the party to station 7400, and an entire new line was run to station 9965, completing line on the 16th day of March, having run over 200 miles of line in 29 working days, with the small party of eight men and one single mule-team for transportation.

The general character of the valley is much the same for the entire distance. No streams were encountered, of any importance, except Wood river, which is crossed with a 100-feet Howe's truss-bridge. The natural bed of the stream lies very low, with bold, abrupt banks, and very seldom is known to overflow. The volume of water can undoubtedly be passed by such a structure, from every indication that presents itself.

The soil is a sandy loam, covered with a dense growth of grass, showing, evidently, that it is susceptible of a high state of agriculture. In fact, the Grand Island settlement, through which the line passes, speaks volumes for itself, every farmer being surrounded with immense cribs of corn, the fruit of last season's harvest; and as to quantity, size of ears, and yield per acre, it has no equal in this part of the country.

The winter months are usually mild, very little snow falling, and stock of all kinds lives principally out of doors, very few farmers having even temporary sheds erected for shelter. I saw large droves, in the month of February, feeding upon the dried grass of the prairie, in preference to the finest kind of hay. They were all in good condition, and many

were fit for beef. I have no doubt that this valley will make one of the finest stock-raising countries in the world. The soil is naturally very dry, and very little rain falls; but, owing to the yearly high water in the Platte, the whole valley is irrigated, giving a rapid, luxuriant growth to vegetation.

Timber is found on the islands in the Platte, in sufficient quantities for present railroad purposes. It consists principally of cottonwood. A stunted growth of cedar is found in many places, but not sufficient for the manufacture of cross-ties. There can be enough cottonwood ties obtained to lay the entire length of the second 100 miles, and an indefinite amount of wood of the same material, which, when dry, makes very good locomotive fuel.

Stone or coarse gravel was nowhere met with on this line, nor in the vicinity.

The subsoil of the entire valley is composed of coarse sand, which will make a very good ballast for the road-bed, and is easily obtained, not being more than two or three feet below the surface. It is also excellent for building purposes.

On returning to Omaha, April 20th, I was ordered to make surveys in and about Omaha, connecting with the river survey and our line as built.

A line was run from the depot grounds north, *via* Florence, to St. Johns, in Iowa, crossing the Missouri river at Florence;

A line from Saratoga, crossing the river directly north of section 10, and connecting with the Florence line on Little Pigeon creek;

A line through 14th street, connecting at station 150, keeping on the west side of the valley;

A line from 14th street line, *via* Bellevue road summit, to intersection on Mud creek, at station 209;

A line from station 209 of Mud creek, *via* Military road summit, to Florence;

A line from station 500, at the mouth of Mud creek, to Missouri river, at Childs's Mill;

A crest line from Florence to Bellevue;

A line from Childs's Mill to Bellevue, hanging on the side hill, to make elevation;

A line from Bellevue landing to station 503 of track.

All the above lines can be found in the map entitled "River Surveys." Profiles of the same are herewith submitted.

In the month of August I divided the party, making two small ones of it, one to re-run the section lines as far as the Government surveys extend, in order to determine more fully the tracks of land the road passed through, for right of way purposes. They were employed on that work till the middle of September, when they were disbanded. The other party was placed under Mr. Maxwell, who was ordered to lay out the towns, and stake out the boundaries of claims upon the line of the road, as far as built.

The towns of Platte Valley, North Bend, Silver Creek, Lone Tree, Grand Island, Brady Island, and North Platte were finished, when, cold weather coming on, the work had to be abandoned.

OMAHA OFFICE.

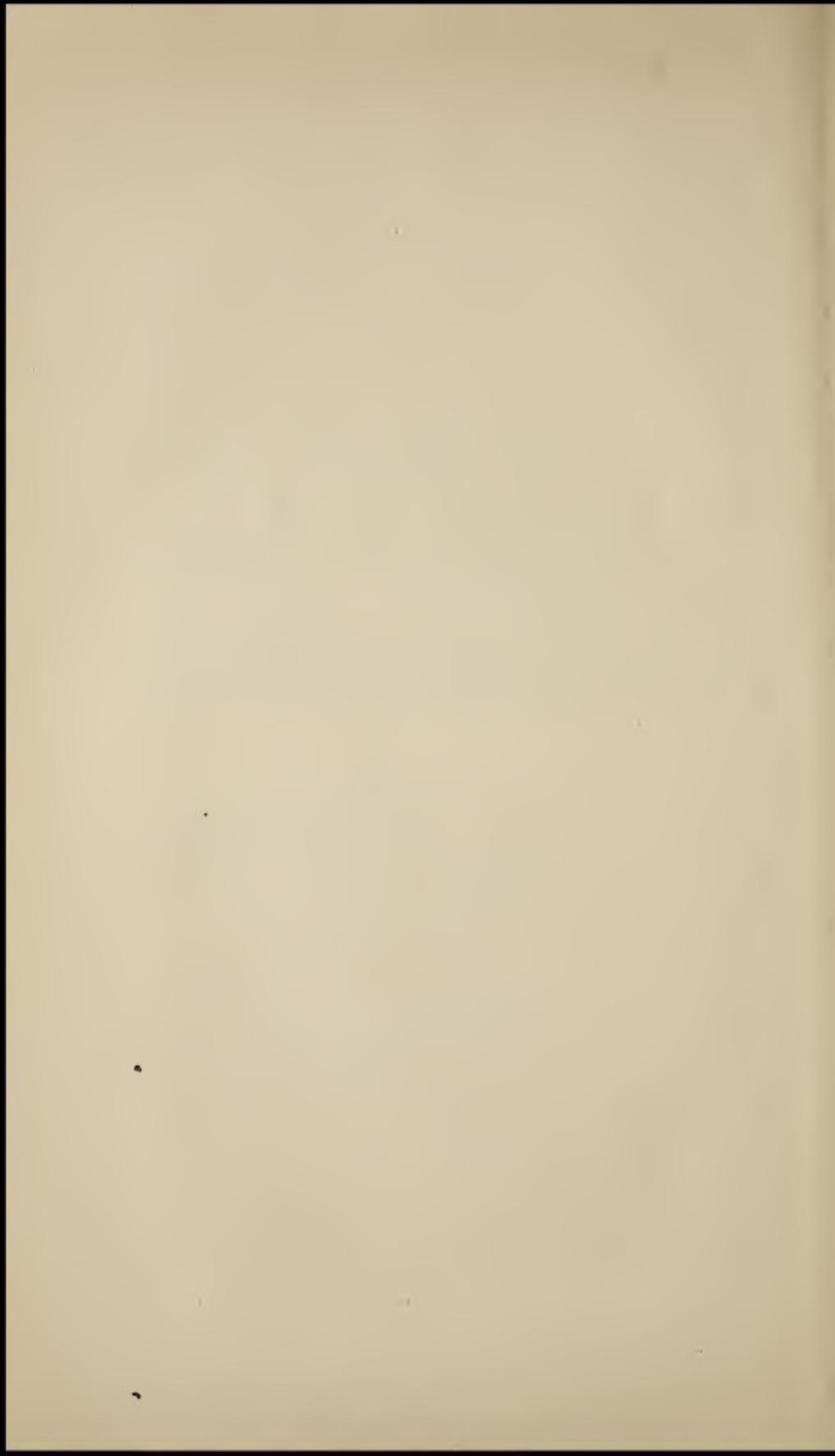
Three draughtsmen have been kept at work since the 15th of July, on maps and profiles, having to make triplicates of all work, and have, consequently, consumed a great deal of time. The following is a list of the principal work done:

Maps of river survey; maps and profiles of the second, third, fourth, fifth and sixth 100 miles; general maps from Omaha to Laramie plains, showing all the lines run; city map of Omaha, showing the position of shop buildings and track on the depot grounds, right of way, records, &c., &c.

To Mr. H. Lambach, Mr. Wm. Cleburne, and Jas. R. Maxwell, assistants, and other members of the corps, I am obliged for valuable assistance rendered.

All of which is respectfully submitted.

J. E. HOUSE,
Division Engineer.



REPORT OF THOMAS H. BATES,

(DIVISION ENGINEER.)

UNION PACIFIC RAILROAD,
DIVISION ENGINEER'S OFFICE,
GREAT SALT LAKE CITY, UTAH, Dec. 31, 1866.

General G. M. DODGE,
Chief Engineer:

SIR: In compliance with your instructions, I have the honor to report the result of my surveys on the Pacific division of the Union Pacific Railroad, for the year ending December 31, 1866, and to forward map and profile of the same.

I arrived at Omaha on the 27th day of June, and immediately reported to you for duty, and on the 28th received from you the subjoined letter of instructions:

“ UNION PACIFIC RAILROAD COMPANY,
“ CHIEF ENGINEER'S OFFICE,
“ OMAHA, June 28, 1866.

“ Captain Thos. H. BATES,
Division Engineer U. P. R. R.:

“ You will proceed to Salt Lake, and take charge of the party made up there by Mr. Smith, under the direction of Brigham Young. You will then proceed to the pass through the Humboldt Mountains, discovered by Mr. Reed in 1865, and through which he ran a line. His line you will extend down the Humboldt and up the Truckee river to the crossing of the California State line at that stream, where you

will connect your line with the California division of the U. P. R. R.; upon doing which you will report to this office by telegraph for further orders.

* * * * *

"These instructions are given upon the supposition that the route indicated is so marked and defined that no other can be found that equals it in direction and feasibility. Should there be any other, you will examine it, so as to determine that question.

" You will note fully the agricultural and mineral resources of the country; the timber, and other building material.

" Collect specimens of the different minerals, labelling each where found. Also, note fully all that may be of interest or benefit to us in building or operating the road.

"I am, very respectfully,

" Your obedient servant,

"(Signed)

G. M. DODGE,

"Chief Engineer."

I left Omaha, in company with my first assistant engineer, Mr. F. S. Hodges, the evening of the 6th of July, and reached this place on the 20th.

On arriving here I availed myself of the first opportunity to call on Governor Brigham Young, who proffered me any assistance I might need in preparing for the trip. A party had been fully organized under his supervision, furnished with two and one half months' subsistence, and had been in camp in his yard, under "marching orders," since the 1st day of July, in compliance with your wishes. I dispatched my party on the 26th, and had the arms forwarded to me at Deep creek by express.

We reached Deep creek the 3d of August, and remained over Sunday. Monday morning, August 5th, we employed "White Horse," Chief of the Goshoots, for a guide, and started for the Humboldt Wells, *via* "Beckwith's cut-off," which had been recommended to me by Mr. Reed. We were assured by "White Horse" that it was a "wino" (good)

road, and that we would find water after one sinip (sleep;) but we learned by dear-bought experience that he knew but little about the country, or, if he did, he failed to impart his knowledge; for, after spending three days in the vain attempt to go by this route, we were obliged to return and take the stage-road *via* Ruby valley. Two days we were without water, except what little we carried with us, and found the roads impassable for loaded teams. We had a severe journey for a short one, and came near ruining all our animals.

At noon of the 14th of August we arrived at Ruby station on the Overland stage-road, two hundred and seventy-six (276) miles west of Salt Lake, and had to lie over two days to have one of our wagons repaired, which had been upset two or three times in Egan cañon, and considerably broken up. Two of our animals had been sick for several days with some distemper, and before reaching Ruby they had become almost worthless, and we therefore turned them out on the Overland Farm, and left orders to have them sold. One we lost, and the other was subsequently disposed of for \$40.

From Ruby station our route was down Ruby valley, forty-four (44) miles, to station No. 22,521 of Mr. Reed's line of 1865; thence, crossing the valley and a divide at its foot, 20 miles, to "Warm Springs," in Clover valley; thence 25 miles through this valley to Reed's Pass and the Humboldt Wells, which we reached on the 22d day of August.

From Ruby station to the Franklin rivers, and crossing the divide between Ruby and Clover valleys, we found the roads in quite good condition; but the balance of the way they were soft and miry, and it was with difficulty that we were enabled to get over them at all.

At the lower or north end of Ruby valley we crossed "Big and Little Franklin rivers," which should more properly be called sloughs. They have their source in the melting snows of the mountain range west of the valley, and empty into Franklin lake. They have a column of about 2,000 cubic feet per minute, and are spread out over two miles of the valley, forming perfect quagmires and sloughs. We were two days packing our provisions and baggage across these sloughs, on our backs, in mud and water 5 feet deep. The

ground was so soft and miry that the empty wagons would sink into it to the box. We paid a ranchman \$25 to haul them over, and it required six yoke of oxen to accomplish it. Several of his cattle got mired in the operation, and came near drowning.

From Warm Springs, in Clover valley, to Reed's Pass, was one continuous quagmire, and our progress would compare favorably with the famous "mud march" on the Rappahannock. We had to unload our wagons from two to six times each day, pack their contents across the streams and sloughs on our backs, and take the wagons apart and haul them out of the mire a piece at a time.

Our progress from this city to the wells was slow and tedious. An unusual quantity of rain had fallen during the spring, making the roads heavy, and, across the mud flats, almost impassable, and it required the greatest exertion, with both man and beast, to average 12 miles per day.

We commenced our survey on the 23d day of August, at station 0 of Mr. Reed's line of 1865, which is in latitude $41^{\circ} 8'$, longitude $114^{\circ} 58'$ west from Greenwich, and completed it at the boundary line of California and Nevada, on the Truckee river, in latitude $39^{\circ} 20'$, longitude 120° west from Greenwich, where we connected with the line of the Central Pacific Railroad of California on the 3d day of November, a distance from the point of beginning of 363.04 miles.

We also ran trial lines through two cañons a distance of $4\frac{1}{2}$ miles, making a total distance of lines run of 367.54 miles in fifty-eight (58) working days, being an average of 6.34 miles per day. The greatest distance surveyed in any one day was 20.27 miles, and the shortest distance 1.36 miles.

The latitude and longitude of the point of beginning are obtained by actual calculations from the courses and distances of our survey, taking the boundary line of California and Nevada as a basis, and agree with a similar calculation made by Mr. S. P. Buck, division engineer of the C. P. R. R., who surveyed the same route the past season; also, with a calculation by Butler Ives, division engineer C. P. R. R., all of which agree very nearly with the previous surveys by the Government engineers.

DESCRIPTION OF THE LINE.

The profile is divided into sixteen sections, each of which embraces a distinctive feature of the country, and for convenience of reference the line will be described by sections.

SECTION No. 1—33 MILES.

(*From station 0 to 1742.*)

This line commences at the head-waters of one branch of the Humboldt river, at an elevation of 5,550 feet above tide-water at San Francisco, and traverses a valley of about 1 mile in width, having 27½ miles of tangent on the section, and an average grade of 10 feet to the mile.

The mountains on the south of the valley have an elevation of 8,000 feet above the level of the sea, and are beautiful and picturesque in appearance, their loftiest peaks being perpetually covered with snow.

On the north of the valley the country is interspersed with low, rolling hills, and represents a broken and rugged appearance as far as the eye can reach.

The valley on this portion of the line contains 20,000 acres of land, which is well adapted to agricultural purposes, being well watered by numerous streams, which have their source in the melting snows and springs in the mountains.

SECTION No. 2—6 MILES.

(*From station 1742 to 2060.*)

From station 1742 to 1800 the line is on a steep side hill, and through a narrow cañon, which is from 200 to 800 feet in width. Between stations 1787 and 1908 a spur of the

mountains deflects the course of the river 6,000 feet to the left, and to obtain good alignment the line is laid across the spur with an ascending and descending grade of 106 feet to the mile. This grade can be avoided by laying the line around the point of this spur; but this portion of the cañon is narrow and crooked, and it would be far more expensive than the line as represented.

Between stations 1950 and 2005 there is an ascending and descending grade of 106 feet to the mile, and a cut of 50 feet at the apex, through solid rock. This grade and cut can be avoided by following Cañon No. 2. This line will be 6,220 feet longer, and, in a distance of 3.7 miles, 2.43 miles will be on a curve with radii from 1,146 to 5,730 feet. The grade through the cañon is shown on the profile by a blue line. The following estimate of quantities shows the difference in cost to be in favor of the cañon line:

Estimate of Quantities by Main Line.—Length of Section, 6 miles.

- 28,300 cubic yards earth excavation.
- 67,000 cubic yards rock excavation.
- 95,000 cubic yards embankment.
- 220 cubic yards masonry in abutments.
- 7,300 feet (board measure) timber in foundations.
- 100 lineal feet truss-bridging.

Estimate of Quantities by Cañon Line.—Length of Section, 7.1 miles.

- 27,700 cubic yards earth excavation.
- 25,000 cubic yards rock excavation.
- 45,400 cubic yards embankment.
- 220 cubic yards masonry in abutments.
- 7,300 feet (board measure) timber in foundations.
- 100 lineal feet truss-bridging.

There are 1,000 acres of land contiguous to this section, available for farming purposes.

SECTION No. 3—22 MILES.

(From station 2060 to 3220.)

The line is on the right bank of the river, and is direct, having 13.3 miles of tangent. The valley has a fall of 7 feet to the mile, and will average 2 miles in width; and at the time of survey (September) had a heavy growth of wild rye and timothy.

The mountains on the south of the river are from 6,000 to 7,000 feet above the level of the sea, and form one continuous chain from the head of Cañon No. 1 to the end of this section. On the north of the river they are not as high, and are more broken and irregular.

This portion of the valley contains 30,000 acres of very superior farming lands, and will produce good crops of grain and grass without irrigation.

SECTION No. 4— $5\frac{1}{2}$ MILES.*(From station 3220 to 3510.)*

This section comprises that portion of the line designated on the accompanying map and profile as "Buck's Cañon."

Rocky spurs from the mountains, on either side of the line, extend into the cañon, and the line cuts them at nearly right angles, and, to avoid heavy rock-cuttings and obtain good alignment, will require ascending and descending grades across these spurs of 40 feet to the mile.

The line crosses the river twice at an elevation of 15 feet above its bed.

SECTION No. 5— $11\frac{1}{2}$ MILES.*(From station 3510 to 4120.)*

Section No. 5 lies between Buck's and Fremont, or Copper cañons.

From the commencement of the section to Station No. 3975, the valley is 1 mile in width, through which a good line is obtained, with easy grades and light work. The balance of the distance it is narrow, and the line is on the slope of the mountains, at an elevation of 10 to 15 feet above the bed of the river.

The excavation on this portion of the line is nearly all rock, and the work expensive, compared with the remaining portion of the section.

The valley through which this section passes contains 6,000 acres of tillable land, requiring no irrigation.

SECTION NO. 6—10 MILES.

(*From station 4120 to 4650.*)

This is the most remarkable and interesting feature of the line. A range of mountains, having a direction nearly north and south, has sometime, in remote ages, formed a barrier to the flow of the waters between this point and the Humboldt Wells or Reed's Pass, and the valley has probably been the bed of a lake. All along the slopes of the mountains the water-line can be distinctly seen several hundred feet above the river-bed.

The river has evidently found a water-course in a strata of slate and clay, and in time worn a channel beneath the layers of solid rock, which has given away and been carried off by the action of the water, and has left a cañon in many places but little wider than the stream itself, with perpendicular walls several hundred feet in height.

The mountains rise several thousand feet above the bed of the river, with mountain on top of mountain, rolling off in the dim distance in almost every conceivable shape.

It gets its name (Copper Cañon) from the fact that prospectors claim to have discovered ledges of copper ore several feet in thickness; but none of the ores have been tested.

The river is from 150 to 200 feet in width, and passes a column of 18,000 cubic feet of water per minute. It is tortuous, and winds around the point of the projecting mountains every few hundred feet of its course.

There will be required six truss-bridges, of 200 feet span each, and one of 150 feet span, with abutments from 15 to 30 feet in height.

Between stations 4256 and 4300 the river makes a detour to the left, around the point of a mountain of solid rock.

The main line shows a tunnel 1,600 feet in length, through Lauterin's Pass in this mountain, and can be obviated by following the course of the river, which is only 956 feet longer than the main line.

The following are the estimates of quantities on this section of each line:

Estimate of Quantities by line through Lauterin's Pass.

- 29,000 cubic yards earth excavation.
- 319,000 cubic yards rock excavation.
- 15,438 cubic yards rock excavation in tunnel.
- 401,100 cubic yards embankment.
- 1,000 cubic yards ballasting in tunnel.
- 2,600 cubic yards masonry in abutments.
- 87,100 feet B. M. timber in foundations.
- 1,350 lineal feet truss-bridging.

Estimate of Quantities by Cañon line.

- 33,400 cubic yards earth excavation.
- 271,000 cubic yards rock excavation.
- 403,600 cubic yards embankment.
- 2,600 cubic yards masonry in abutments.
- 37,100 feet B. M. timber in foundations.
- 1,350 lineal feet truss-bridging.

SECTION No. 7— $68\frac{1}{2}$ MILES.

(From station 4650 to 8263.)

From the commencement of the section to Station No. 5140 the valley is narrow, being not over one-half mile in width between the foot-hills, with low, uniform hills on each side of the river.

At this point there is a range of mountains, having an opening of 800 feet, called Bea-owawe Gate.

This range extends south into the desert, and has the appearance of having sometime formed a dam to the river, for the water-line can be distinctly seen high upon its slopes.

Here the character of the country has a marked change. The mountains have more distinct ranges, having their general course north and south, and the valley, each side of the river, is broad and fertile, producing heavy growths of grass and wild rye.

From station 5140 to 5410 the valley is from 4 to 6 miles in width. Here the river cuts at right angles another range of mountains, which has an opening barely wide enough for its channel. This is one of the famous range of mountains containing the silver mines of the Reese river district.

From this point to the end of the section the valley is from 10 to 15 miles in width. On the south side of the river, for one-half mile in width, the land is of a good character for farming purposes, but fades away into an alkali desert. On the right bank of the river the land appears to be of a better quality, and can be made available for agricultural purposes.

From station 8110 to the end of the section, the line is across an alkali flat, which is dry and hard, and will make, when thrown up, a firm road-bed.

From station 5540 to 7820 the proper location for the road is on the right bank of the river. The line will be more direct, with less curvature, and will encounter fewer sloughs and old water-courses.

Station 6470 is the nearest available point the line can be reached from Austin—distance, 90 miles, *via* Reese river valley. There are 150,000 acres of land adjoining this section, which can be made available for agricultural purposes.

On this section the alignment is good, grades easy, and work light.

SECTION NO. 8—7 MILES.

(*From station 8263 to 8633.*)

There are no very great engineering difficulties to be overcome in building the road through Ives's Cañon. The cañon is from 400 to 2,000 feet wide between the foot-hills, and is sufficiently direct for a good line, with easy grades; and, for a cañon, not expensive work.

The mountains in the vicinity have the appearance of containing deposits of silver. One of the party, an old California miner, found some rock which he regarded as good specimens of silver and gold ore. After reaching the mining region, I learned that the mountains had been "prospected," and claims staked off and recorded, but no attempt had, as yet, been made to work them. The claims, however, are for sale, and probably will be purchased by New York capitalists.

SECTION NO. 9—118½ MILES.

(*From station 8633 to 14896.*)

From Ives's Cañon to the French Bridge, near station 9790, the line has a good direction through a fine, open, fertile valley, containing a belt of good agricultural land, varying from 1 to 5 miles in width, which produces abundant crops without irrigation. Along this portion of the line is a belt of what is termed "sage-brush land," of an equal extent, which is said to produce fine crops by irrigation, and ranchmen prefer it where it is not too expensive.

The first ranch we reached in the Humboldt valley is opposite station 8790. Here are a few acres in cultivation, and the large stacks of hay and grain demonstrate the productiveness of the soil.

The next, and most extensive one, is Fairbanks's Ranch, opposite station 9156. Here several hundred acres of land are under cultivation, and the substantial buildings, large herds of cattle, sheep, and swine, present a degree of prosperity that one would not expect to find in this isolated region. This portion of the valley was quite extensively settled in 1862-'63, but now the desolate fields and dwellings present naught but a heap of blackened ruins to mark the spot where they once stood, and show too plainly the ravages by hostile Indians. The country is well adapted for agricultural purposes, the average crops being 40 bushels of barley, 30 bushels of wheat, and 200 bushels of potatoes per acre.

Soon after passing the Santa Rosa range of mountains the character of the country changes again. The river has worn a deep channel in the clayish soil, forming escarpments ranging from 50 to 150 feet above its bed. The narrow belt of plain along its shores is strongly impregnated with salt and alkali; and, although it produces heavy crops of grass, it is worthless for grazing purposes.

From French Bridge to station 12936 the line is on a bench from 50 to 150 feet above the bed of the river. The soil, for a greater portion of the distance, resembles hard-pan, with an admixture of small stone and gravel, the detritus from the wash of the mountains, and will make an unexceptional road-bed.

The only objectionable feature in this portion of the line is the crossing of the Humboldt river between stations 12650 and 12700. This can be avoided by crossing to the right bank of the river, between stations 10343 and 10974, or by continuing the line on the left bank, and crossing at the ferry above Humboldt Lake, as represented by a dotted line on the map. At either of these points a crossing can be effected with a truss-bridge of 200 feet span.

The tangent at station 10974 should be extended to Mill City, which will avoid two crossings of the river.

From station 13000 to 13550 the line is across a plain having a growth of sage-brush 6 feet in height, with a light soil, resembling dry ashes, and has the appearance of having been run over by fire. This material will not answer for the road-bed, and it will have to be hauled with gravel-trains from borrowing pits from other portions of the line after the track is laid.

From station 13550 the line turns a spur of the mountains with a gentle curve, and enters an alkali flat at station 13650, which extends to station 14070, where it commences ascending on the slope of the mountain and crosses a divide between Humboldt Lake and Humboldt Sink, and enters another alkali flat at station 14550, which continues to the end of the section. These flats, when thrown up into an embankment, will make a good and firm road-bed.

At the head of Humboldt Lake lie the "Big Meadows," which have an area of about 6,000 square acres of good grass-lands. They are mostly taken up and occupied by farmers.

A large stamp-mill is being erected by a company from Utica, N. Y., on the stream in the cañon between the lake and sink, and a new mining district has been organized and is being developed by this company.

The Humboldt valley on this section contains 70,000 acres of land, susceptible of cultivation without irrigation, and an equal quantity which can be made available by that means.

SECTION No. 10—12 MILES.

(From station 14896 to 15523.)

This section embraces that portion of the line crossing the divide between the Humboldt Sink and the Truckee Desert. The alignment is good, work light, with an ascending grade of 60 and a descending grade of 72 feet to the mile. The grade can be improved at the expense of alignment, as shown by a dotted line on the map.

SECTION No. 11— $13\frac{1}{2}$ MILES.

(*From station 15523 to 16224.*)

This portion of the line is across the Truckee Desert, which is perfectly dry, and the earth is light, and, during high winds, drifts like snow in a gale. The road-bed will require ballasting with either broken stone or gravel, to prevent its being carried away by the winds, which sweep over the Desert with great force.

SECTION No. 12— $6\frac{3}{4}$ MILES.

(*From station 16224 to 16605.*)

This is also a desert, and has been formed by the accumulation of dunes or drifting sands for ages. It has an elevation of 48 feet above the Truckee Desert, and lies between it and the Truckee river. To ascend it will require a grade of 78 feet to the mile, for 6,600 feet, which cannot be avoided. The road-bed will require ballasting.

SECTION No. 13—16 MILES.

(*From station 16605 to 17424.*)

Commencing at the "Great Bend" of the Truckee river, the line is laid along the bank of the river in a narrow, crooked cañon, to station 17160, where it opens out into a beautiful, fertile valley, 1 mile in width, which continues to the end of the section, and is known as the "Little Truckee Meadows." The "Truckee Meadows" are well adapted for agricultural purposes, and the land is all taken up and occupied.

The general course of the river is direct, but it has innumerable sharp curves and bends, being deflected out of its general course by rocky spurs, which project from the ad-

joining mountains, and have to be crossed with heavy rock-cuttings, to avoid expensive and extensive bridging.

The mountain ranges on either side of the river are high and beautiful in form, having an elevation of from 5,000 to 7,000 feet above the level of the sea. They contain strata of white and red chalk, lime, and primitive granite, and have almost every known color. When the rays of the setting sun are reflected from them, they present a romantic and picturesque appearance.

A good line was obtained, with easy grades; but the work will be expensive.

SECTION No. 14—10 MILES.

(*From station 17424 to 17952.*)

This section is entirely within the cañon, having the same general features as the one above described, with this difference: the valley is broader, and contains occasional strips of bottom-lands along the shores of the river, which sustain a sparse farming population, who are devoted to raising grain, for which they find a ready market with emigrants and freighters. The expense of the work can be materially reduced by crossing the stream several times, thereby requiring considerable bridging, instead of clinging to the sides of the mountains.

SECTION No. 15—5 MILES.

(*From station 12952 to 18216.*)

Emerging from the cañon brings us on to the "Big Truckee Meadows." This is a beautiful dale, having an area of 25 or 30 square miles, entirely surrounded by mountains of great height. The Meadows were first settled in 1859, and now contain a population of 500 souls, *of all sorts*, who are devoted to trade, agriculture, and mining. The principal production is hay, although there are some 2,000 acres culti-

vated to grain, giving an average yield of 40 bushels per acre. On the banks of the Truckee stands the handsome little town of Glen Dale, which contains all the population of the valley. The line crosses the Meadows and passes through the town of Glen Dale. The grade on the profile is laid high, for the reason that the meadows overflow each spring; and it will require an embankment 5 feet in height to keep the road above water at all seasons of the year.

SECTION No. 16—18.04 MILES.

(From station 18216 to 19168+77.)

Commences at the foot-hills of the Sierra Nevada Mountains, and terminates on the Truckee river, near Crystal Peak, at the boundary line of California and Nevada, 5,195 feet above tide-water at San Francisco.

This portion of the line has the general characteristics of the cañon portion of the Truckee already described. The river is tortuous in its course, and its banks rise rapidly to its source, requiring heavy grades and curves of short radii.

It is 32 miles from the State line to the summit of the Sierra Nevada Mountains, by the line of the Central Pacific Railroad of California; 45 miles to Cisco, the present terminus of the track; and 138 miles to Sacramento. The highest elevation reached by the C. P. R. R. is 7,042 feet above the tide.

The Truckee river passes a column of 23,000 cubic feet of water per minute, and will furnish an immense water-power; and when the railroad is completed, along its banks will be heard the sound of stamp-mills and machinery, working up the "big trees" and ores of the surrounding country.

HUMBOLDT CANAL.

A stock company was organized in 1862, with a capital of \$200,000, to construct a canal 60 miles in length, from the mouth of Ives's Cañon to a point on the Humboldt river, in

the mining district, to furnish water-power for stamp-mills, transport ore, fuel, &c.

At the terminus of this project, a large town, named Mill City, was laid out into building-lots, streets, alleys, courts, parks, drives, and a race-course, with a suitable quantity of ground reserved for "religious and benevolent societies of any denomination, and the most liberal provisions made for establishing and maintaining a first-class free school."

The canal, as projected, was to have been 15 feet wide on the bottom, with a depth of 5 feet of water, and to have a fall of 113 feet. It was contemplated that the ore from Humboldt City, Star City, Santa Clara, Prince Royal, Dun Glen, Unionville, and Winnamucka, which are within a circuit of 20 miles, would be transported to Mill City and worked by the water-power to be furnished by the "Mill City and Water Company." The canal was commenced in 1862, and completed for a distance of 45 miles, and then abandoned.

Mill City did not progress as far; for, at the time of the survey, it contained only one small store and a stable, with a population, all told, of one man and a boy.

The canal can be turned to good account. It can be completed at a trifling expense, and will furnish the means for irrigating a large tract of country.

MINERAL RESOURCES.

So much has been written on the mineral resources of the State of Nevada, and the subject is so well understood, that any report in connection with the recent survey would seem almost superfluous. The subject cannot be treated within the limits assigned to a report of this character. A work by J. Ross Brown has recently been published by Congress, giving all the information on this subject which would be of any practicable utility to any one. I will take the liberty, however, of saying, that although the Humboldt district is rich in deposits of the precious metals, and the ores yield from \$20 to \$65 per ton, the cost of transportation, labor,

and living are so great that none of the mines will pay the expenses of working until the railroad reaches the Humboldt valley, and reduces the cost of transportation, &c.

VIRGINIA CITY.

This city is 16 miles south of the Truckee river, in a direct line; and the two most available points at which it can be connected by rail with the Pacific road are Hunter's and Glen Dale, on the Truckee river, which will require a road 40 miles in length.

Virginia City is the centre of the mining interest of the Pacific coast, and the day is not far distant when a railroad connecting with the Pacific will be required to lessen the expense of the transportation of lumber, fuel, and other material required in working the mines. Without going into particulars, I will state that the cost of delivering freight will pay the first cost of a road every four years.

TIMBER.

Timber suitable for ties, bridging, or other railroad purposes, is not found anywhere in the Humboldt valley. A few of the mountains are sparsely covered with cedar, of a stunted growth, but it is neither accessible nor in sufficient quantities to be relied upon even for fuel. The only available section where a supply can be obtained for constructing and operating the road is the Sierra Nevada Mountains, which are covered with a heavy growth of cedar, redwood, and pine. Sawed lumber, in large quantities, can be procured at the mills on the Truckee river, for \$18 per M. feet; and wood on the line of the road, above Crystal Peak, for \$16 per cord in gold.

STONE.

Stone suitable for bridge abutments, piers, &c., can be quarried from the mountains contiguous to the line, and on

the Truckee river, from the rock-cuttings in grading the road. There is also in the neighborhood of Mill City a limestone quarry, and an ample supply of plaster of Paris.

COAL.

No discoveries of coal have been made anywhere in the country through which the road will pass. The only indications of this mineral are seen in the Sierras, in the vicinity of Crystal Peak, where "it is believed that coal of a superior quality, and in inexhaustable quantity, has been discovered."

In conclusion, the surveys of the past season have demonstrated beyond a question that the Humboldt valley possesses more natural advantages for constructing and operating a railroad than any other route which can be found between the Great Desert and California, and I have no hesitation in recommending its adoption. It resembles, in many respects, the valley of the Mohawk, from Schenectady to Utica. It is susceptible of sustaining a large agricultural population; and when a continuous line of rail connects the Atlantic and Pacific coasts, emigration will seek its fertile soil and salubrious climate. Snow rarely falls, and even then it lies on the ground at most only a few hours. Fruits, flowers, and shrubbery can be grown in great profusion. The long vista of mountain ranges that project into the valley, terminating either in graceful slopes or rugged precipices, as seen through the wonderfully transparent atmosphere of the Great Basin, in gazing along the meandering river which courses through the broad and verdant Humboldt meadows, constitutes an outline which, in symmetry, is seldom equalled.

Before closing I desire to express my obligations to Mr. F. S. Hodges, first assistant engineer, for his valuable services. He is a young man of great energy and perseverance, thoroughly devoted to his profession, and it gives me great pleasure to recommend him to the favorable consideration of the company.

To Jno. F. Smith, second assistant engineer, and Heber Young, who have each rendered me valuable assistance.

Also to Governor Brigham Young, for his uniform courtesy, and for the valuable assistance rendered in furnishing men and supplies for the survey.

And to Messrs. Gilbert and sons, for many kind attentions to my wants while sojourning in Great Salt Lake City.

All of which is respectfully submitted.

THOS. H. BATES,

Division Engineer.

Summary of Abstracts Nos. 2 and 3.—Total Ascending and Descending Grades.

Level.	0 to 20 feet per mile.	20 to 40 feet per mile.	40 to 60 feet per mile.	60 to 80 feet per mile.	80 to 100 feet per mile.
Distance in miles.	Distance in miles.	Distance in miles.	Distance in miles.	Distance in miles.	Distance in miles.
65.39	180.53	* 92.423	7.353	10.802	6.542

No. 5.—Table of Alignment.

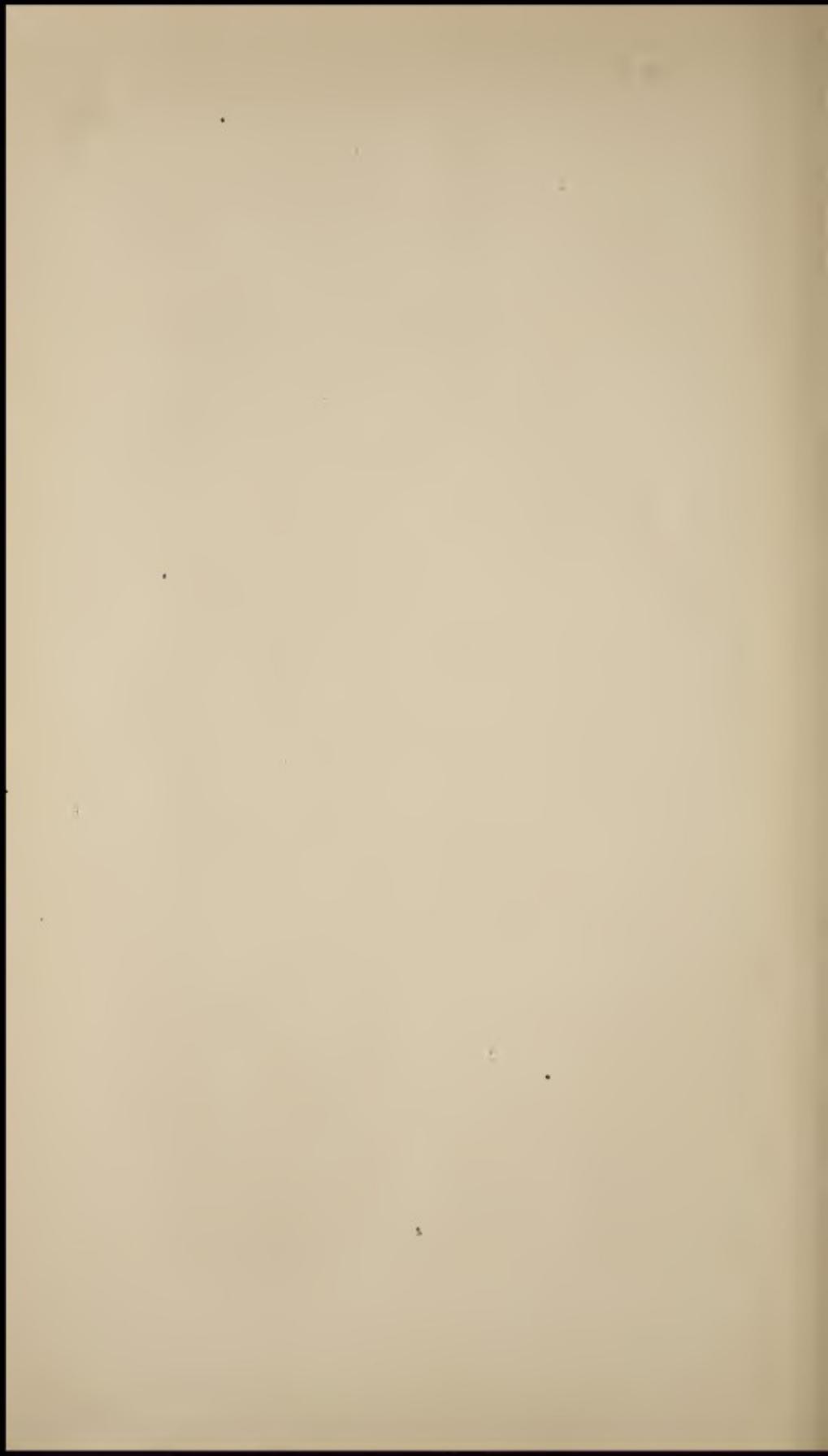
$\frac{1}{4}^\circ$	$\frac{1}{2}^\circ$	1°	$1\frac{1}{2}^\circ$	2°	$2\frac{1}{2}^\circ$	3°	$3\frac{1}{2}^\circ$	4°	5°	6°
Radius.	Radius.	Radius.	Radius.	Radius.	Radius.	Radius.	Radius.	Radius.	Radius.	Radius.
22,918	11,459	5,730	3,820	2,865	2,292	1,910	1,637	1,433	1,146	955
*12,94 m.	19,66 m.	17,49 m.	2,17 m.	8,90 m.	3,0 m.	8,50 m.	0,34 m.	3,51 m.	0,50 m.	1,41 m.

Tangent	.....	78.29 per cent.
Curve	.....	21.71 per cent.

Length of Tangent Line.....	284.22 miles.
Length of Curve Line.....	78.82 miles.

Total 363.04 miles.

* Length of curves measured by chords.



REPORT OF DAVID VAN LENNEP,

GEOLOGIST U. P. R. R.

NEW YORK, January 1, 1867.

General G. M. DODGE,

Chief Engineer of the U. P. R. R., Omaha:

GENERAL: Having been engaged, in the early part of last June, as geologist, to accompany a party of engineers of the U. P. R. R., I address to you the present report of my observations of the geology of the country I visited.

I joined the party under the direction of Mr. J. A. Evans, division engineer, to which I had been assigned. Thus my observations really commenced from this point westward. I will, then, trace the route followed by the party, to show you the ground gone over.

We first kept along the valley of the Lodge Pole creek to Camp Walbach; from there we followed the foot of the Black Hills to La Porte; then, coming back on our steps to the Lone Tree valley, we crossed the Black Hills at Evans's Pass; descending by the western slope in the Laramie plains, we passed by Fort Sanders, and followed the Big Laramie and Laramie rivers to where the last cañons. We entered the cañon for three days; then, coming back to camp, we took the Fort Halleck road, and went to Fort Laramie. From thence we ascended the Laramie river up to its cañon, and going across the mountains to the last point visited in the cañon, (where we entered it by its western entrance,) we followed it to its eastern entrance. Leaving the last place, we went across the country to the Chugwater creek, and taking the road to La Porte, we stopped on the Crow creek, followed its course down a few miles, and then went to La Porte. Again we went back north to Jack

Springs, and from thence, cutting across the country to the point last visited on Crow creek, we followed its course to its mouth.

Besides this, when we were at Camp Walbach, I went north about 25 miles on the Chugwater creek; and again, when at La Porte, I visited the bluffs, about 15 to 18 miles northeast of that place; and lastly, in going back to Omaha, I visited Boulder City and Bellemont in your company. It must be borne in mind, however, that I passed over some part of this ground at the rate of nearly 20 miles a day, with little chance of investigating the nature of the country, while some parts I visited more thoroughly.

The two marked features of the country are the mountains and the table-lands or prairies.

Of the mountains, first are the Black Hills, (called also Laramie Mountains, to distinguish them from the Black Hills, northeast of these hills.) It is a range of the main chain of the Rocky Mountains. It occupies the western part of the country, and seems to be a fold joining the main chain southwest of La Porte, running in a north-north-easterly direction, from the last place mentioned, to a few miles north of the Box Elder creek. Here the mountains are farther west, and follow again the same line (as seen north of this, at the head-waters of the Lone Tree creek,) to a few miles from the mouth of the Sybille, with a more northerly or north-northwesterly direction.

It is an open question with me whether the range joins the main chain north of the Box Elder or southwest of La Porte, as I did not visit the first-mentioned spot.

As I said before, the range is continuous in one general direction to near the mouth of the Sybille. There, much of the hills are washed away, forming a break in the continuity, and having drift or alluvium overlying the rocks. The rocks farther north of this point are more metamorphosed. Beyond this point, also, the range apparently runs northwest and almost west, and spreads on a wider area. It ends on the north side by small hills, as far as the eye can reach, seen from the bluffs overlooking the Laramie river.

And, second, are the Medicine Bow mountains, another range of the Rocky Mountains. (This is the farthest point west I gazed upon.) They are west of the Black Hills, joining the main chain farther west, and running apparently northwest, or nearly parallel to them. They end at the northwest, by small hills, a good deal farther South than the Black Hills, as seen from the Laramie plains. This range is the highest of the two. I did not visit it.

The lowest point on the Black Hills is about 8,400 feet; the highest, from 9,000 to 9,500 feet above the level of the sea.

The table-lands occupy all the country from Julesburg to the Black Hills. Going west, it gradually ascends, the elevation being, at the mouth of the Lodge Pole, about 3,600 feet, and at Camp Walbach, at the foot of the Black Hills, about 7,000 feet, a distance of about 150 miles, a mean of nearly 23 feet to the mile. The first 100 miles have a mean of about 15 feet to the mile; the last 50 miles, about 40 feet to the mile. Going north and south of the valley of the Lodge Pole, the ground descends towards the North and South Platte rivers. The slope on the south side, at about a distance of 100 miles from the mouth of the Lodge Pole, on a line directly south, towards the mouth of the Crow creek, I reckon to be about 13 feet to the mile. (For elevations on which this was calculated, I am indebted to the engineers of the party.)

These table-lands also occupy the plains between the Black Hills and the Medicine Bow mountains, but they have an elevation of several hundred feet above the first.

The first are formed by horizontal strata, cut up by valleys and overlaid with drift; while the second are underlaid with uplifted strata, at an angle of a few degrees where I saw it, (being, probably, the synclinal valley of the two ranges,) overlaid with the same drift as the first, although of somewhat different materials.

Some of the table-lands are very barren. Those lying east of the hills, bordered by the Laramie river, north; the Chugwater, east; and south by the hills, advancing east,

show evidence of poor soil, giving sustenance to very little grass of meagre quality. This is true, also, on some portions of the table-lands bordering the lower part of Crow creek and Lodge Pole creek, some having a thick growth of cactus, rendering the travelling of a pedestrian difficult and dangerous.

Another feature of the country are the basins and valleys which have emptied them. Both of these have been cut out at an age subsequent to the formation of the youngest rocks overlying the country.

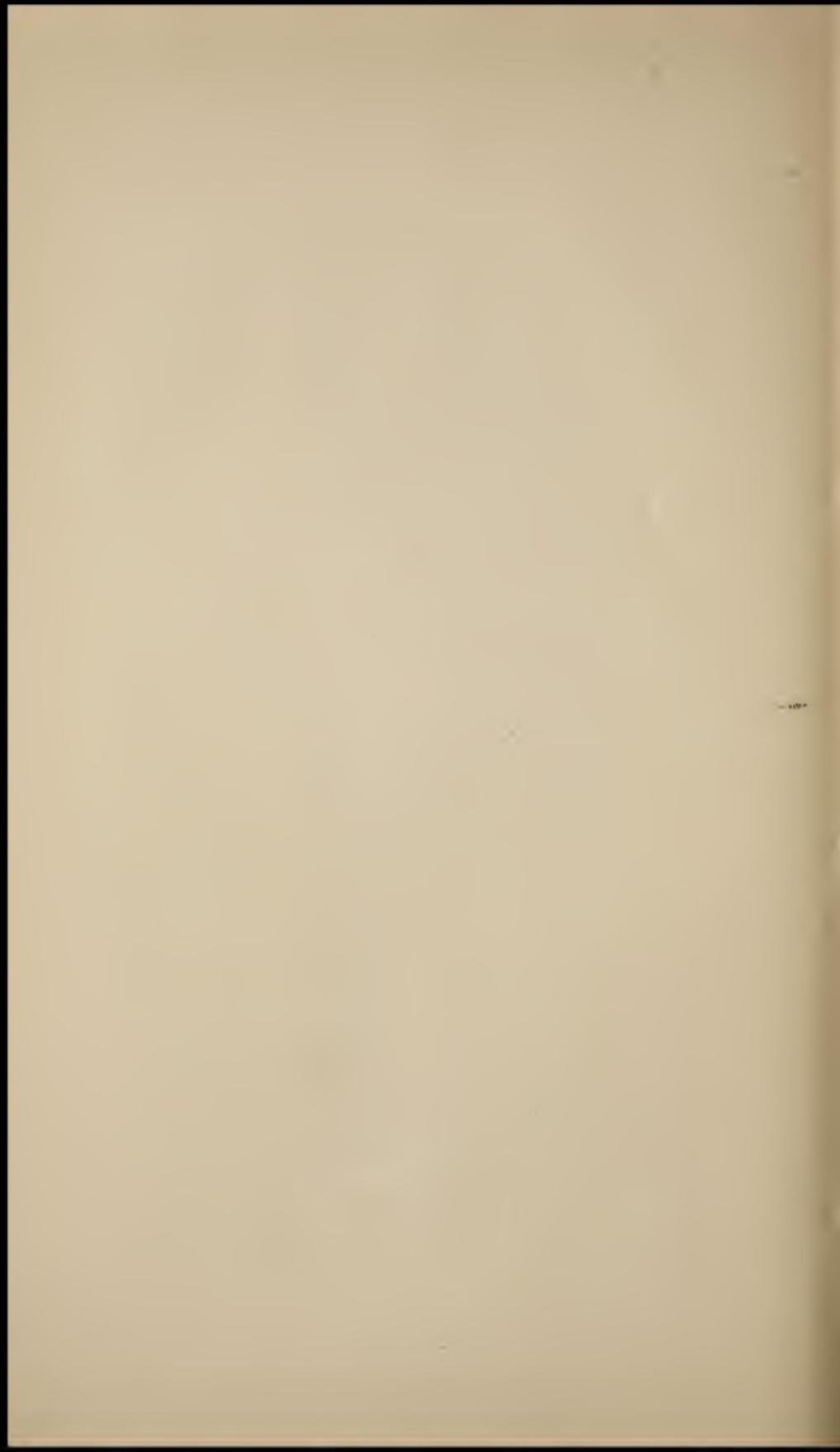
There are several basins noticeable. One is the Great Basin of the Laramie plains, which found, probably, outlets over the Black Hills, principally by Evans's and Sybille Passes, and more latterly through the Laramie cañon. It took its final flow in this place, probably, by the deep bed which it more readily dug for itself through the break and displacements of strata, which were occasioned by great masses of trap and basalt that have found their way to the surface. In some places in this cañon these masses stand in majestic rocks on the river banks, reaching to the skies, say about from 1,500 to 2,000 feet and over. Some of the sketches that I left with Mr. J. A. Evans and yourself show the character of these features of the cañon. I call the basin mentioned above the first Laramie basin.

Another basin, which is the continuation of the first one, is the basin east of the Black Hills, being bordered south by a fold of the hills, the Sybille, the Chugwater, and the Horse Shoe creeks finally running through it. I will call this the second Laramie basin. It would be more appropriate to call this a water-course.

A marked basin is noticed at the foot of the hills south of the last mentioned. It is bordered on the west by the Black Hills; on the north by an additional fold of the same, extending the hills at this place farther east; on the east by the table-lands; and on the south by the same, and drift. Its waters are now separated by divides of the valley of the Lodge Pole. It extends from the valley of the Crow creek to the valley of the head-waters of the Chugwater inclusive.

PLATE I.





The Crow, Lodge Pole, Horse Shoe, and Chugwater creeks and their tributaries cut this basin in its breadth.

South of this are the valleys of the Lone Tree and its tributaries, which give outlet to a basin in the mountains, and one near the hills, where these recede from the line north of the Box Elder. Then is the valley of the Box Elder. All these empty into the large basin of the Cache la Poudre. The Crow and Lone Tree creeks have first a course nearly due east, and then turn rather abruptly to the south, emptying their waters into the South Platte. The course of the Box Elder makes a more regular curve from east to south.

There are again, in the valley of the Lodge Pole, two smaller basins, formed by the obstruction which the younger rocks offered to the flow of the waters, these having cut a comparative narrow passage of a few miles through them. The upper one is at the White bluffs, and the lower one is at a point about 36 miles from Julesburg, near the crossing station of the Laramie road. Plate I is a sketch of this place.

The drift and these basins and valleys denote a subsequent age to those in which the rocks were formed. This has again been followed by terrace-formations along the valleys. It is a very marked feature of all the water-courses. Deposits of alluvium of vegetable matter, forming rich soil, are also noticeable in most of these valleys, while at a few places the decomposition of calcareous and clayish soft rocks has spread over the valley, rendering them barren. It is also these rocks which render the waters of these streams muddy on going over the prairies, while in many places, for several miles at a time, the waters lose themselves under the thick beds of accumulated sands.

The pebbles composing the drift are usually of such rocks as you see on the mountains. Pieces of granite of various kinds, of porphyry, of trap, of various kinds of hornblendic rocks, of mica schists—these are prevalent in the upper parts of Crow creek, the Lone Tree, and its tributaries.

Pieces of granite, but more especially small pieces of quartz and feldspar, with many chalcedonies and jaspers, are prevalent as you ascend the course of the Lodge Pole. Moss agates are met once in a while. In addition to these you

find, on the Chugwater, a feldspathic rock and magnetic iron. In the sand of one of its tributaries I got a black sand, which proved to be magnetic iron.

On the Laramie river you do not find the magnetic iron, but all the others; also, ortholase, and more hornblendic rocks.

In the first Laramie basin, along the Big Laramie and Laramie rivers, there is, in some places, a prevalence of a dull yellow, hard sand-rock, jaspers of deep colors, and also a hard limestone, containing fossils of the carboniferous ages; in other places a predominance of hornblendic rocks. In some localities the boulders are larger. You find, also, chalcedony in some places.

There are two main basins, which may be called the hydrostatic basins, that border this country on the northeast and southeast. They are the basins of the North and South Platte rivers. The waters of the more recent basins, mentioned above, flow into these.

The valley of the South Platte, which I visited, has very rich soil where the alluvium covers the bottom, but where this is washed away there is nothing but sand; or it may be covered by fine sands, which, in places, form hills.

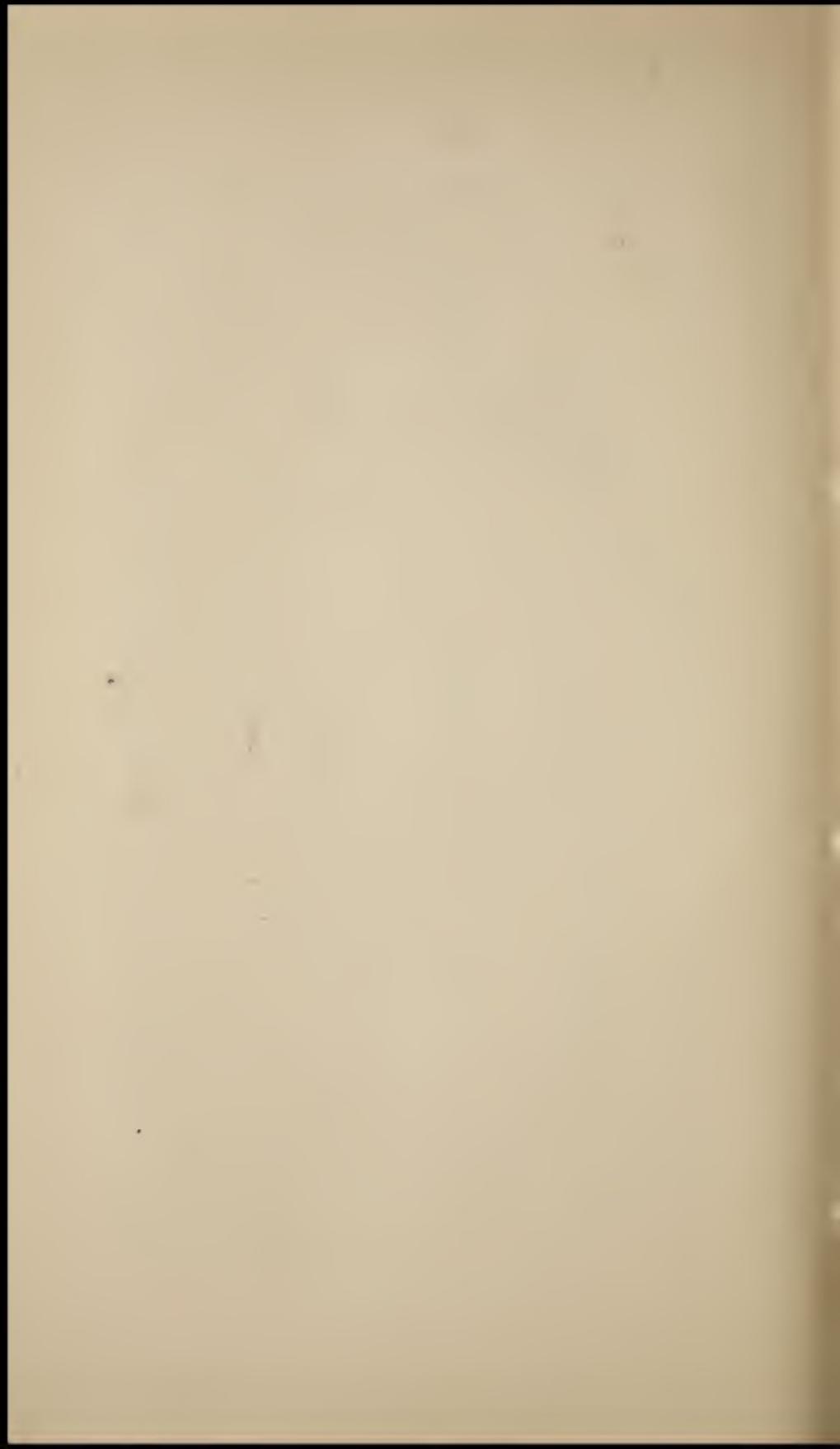
The rocks found in place are igneous, metamorphic, and sedimentary. They are uplifted and horizontal. The igneous and metamorphic rocks are found on the hills. The igneous are trap, porphyry, basalt, &c. I also found boulders (washed away) of lava.

Trap dykes are seen to a limited extent along the Cheyenne and Evans's Passes. Above the waters of the Lone Tree there is a dyke of trap and porphyry; also, numerous quartz veins. In the vicinity of Camp Walbach Mr. Evans showed me a small dyke, and I found a larger one farther south.

You see trap and basalt in large dykes and uplifted masses in the Laramie cañon. At one place, which was very noticeable, you see how the trap pushed the granite up, made a break, and filled a place between the layers so that it bulged out. Plate II.

PLATE II.





The metamorphic rocks—those mostly metamorphosed—belong, according to Dr. Hayden, to the azoic rocks, having found the younger formations lying unconformably to these in the other parts of the country visited by him. The greater part is a flesh-colored granite, composed mostly of feldspar of the same color, which has an easy cleavage, and disintegrates by the weather.

There are other kinds of granites and syenites, hornblendic rocks of various kinds, mica schists, gneiss, chloritic schists, and feldspathic rocks, but they are not so abundant. These occupy the middle part of the hills generally, but sometimes the whole width, and are intermixed with igneous. Above the Lone Tree, at Evans's Pass, and at Cheyenne Pass, the red granites are predominant; above the Chugwater, white and red granites and feldspathic rocks. I found here a bed of magnetite, of large proportions.

On reaching Camp Walbach, Mr. Evans informed me of the existence of pebbles of iron ore on the Chugwater creek, and proposed to visit the place to find, if possible, the bed of this ore. Having taken an early start, we reached the Chugwater at about $11\frac{1}{2}$ o'clock a. m., in a wagon, and, after selecting a proper place for the night, we left in search of the ore. We succeeded in tracing it, with a good deal of trouble, for about 8 miles, to the foot of the higher hills, late in the afternoon. Here we found the pieces more abundant; but on ascending the first hills we lost them again. We pushed on, however, in the direction we thought it to be, and found the pebbles again, and soon after we came on a small outcrop. Taking then the direction of the strata, we went forward and saw, after a while, the object of our search. On a high hill, about 700 to 800 feet higher than where we stood, the black rock was seen on the top and descending (as shown by outcrops at different points) to the bed of the stream, on whose opposite bank we stood. The outcroppings are about 20 feet wide, but those of different rocks on each side must be about 150 to 200 feet apart, indicating a wider bed than what is seen. Further investigation was impossible, on account of the late hour. To have waited for another dawn of day

would have found us famished, having no provisions with us; we therefore retraced our steps, and reached our camping-ground by 10½ p. m.

At the western part of the Laramie cañon the red granite predominates, while of a lighter color in the middle and eastern end. The hornblendic rocks are very abundant. Mica schists, with and without garnets, are abundant. Chloritic schists are met with also.

Rocks less metamorphosed overlie the preceding ones. They are red shales or slates, limestones, and sandstones, the most prominent being a red sandstone, which is very conspicuous, and forms one of the peculiarities of the landscape from La Porte to the Chugwater.

These rocks are seen on both slopes of the Black Hills. On the eastern, at La Porte, they are high on the hills, with a dip a little south of east, I judge; and as they go north, the main part has a north-northeasterly strike, curving northwest as you go north, with a larger angle of elevation and a rather more easterly dip, until, when you reach beyond the head of the Chugwater, you find them to have an angle of about 75° dip westerly.

These rocks are not seen farther north on this slope, as far as I have been. The general strike of these rocks, though in the direction described above, apart have a different strike, which cuts the first at an obtuse angle, forming a zig-zag line, thus :

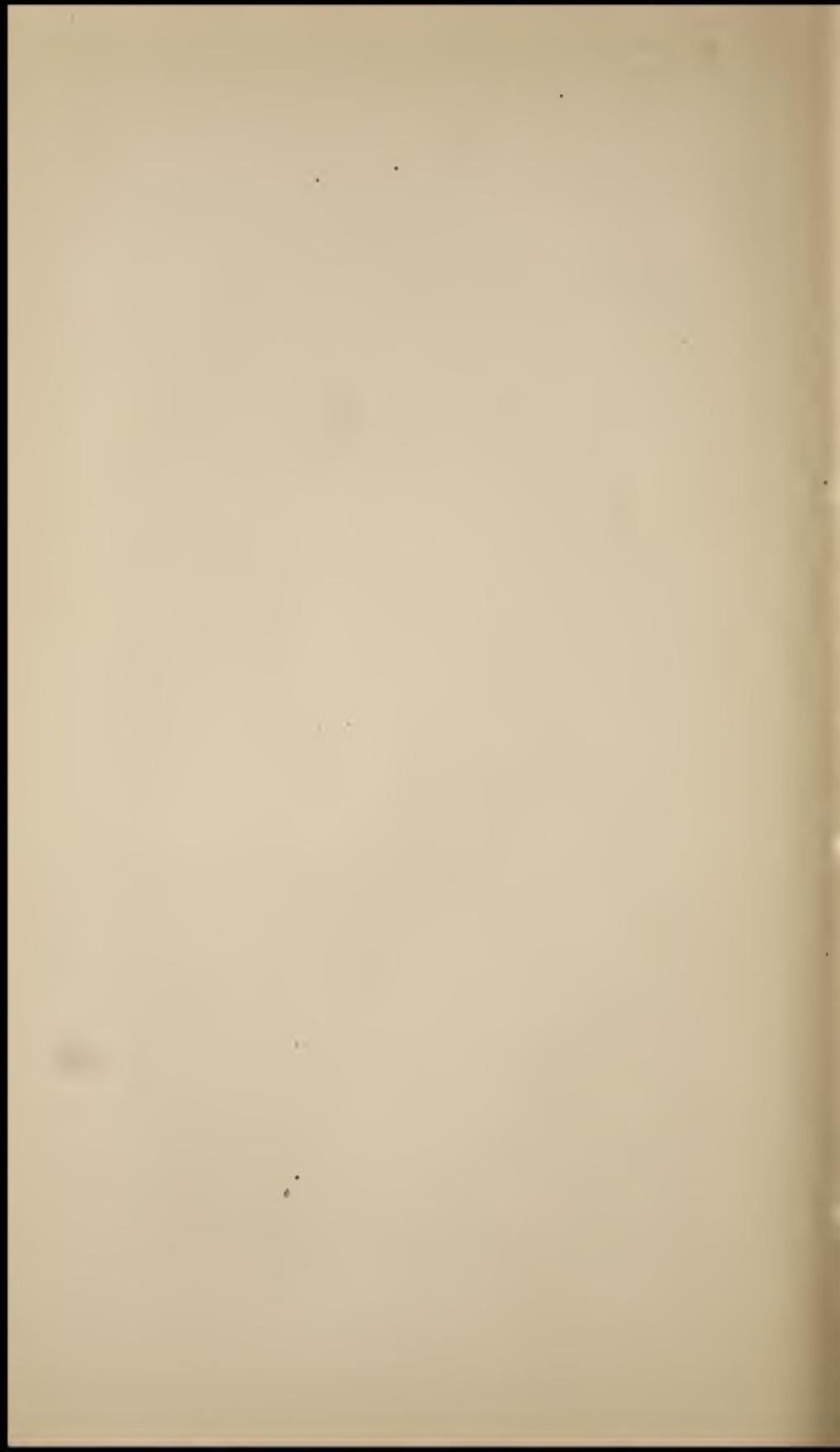


The dip of the smaller line varies much, being sometimes northwest or west, or in any other direction. At one place seen above Camp Walbach, the change in strike has occasioned a break in the rocks, which is distinctly seen from the bottom of a precipice.

On the western slope the dip of these rocks, occupying



PLATE III.



the foot of the hills below Evans's Pass, is westerly, at an angle of about 5° to 10° ; but, as you go north, they are seen up to nearly the top of the hills, with a more southerly dip, and at an angle of about 25° .

The prominent red sandstone is seen in the southern part of the Laramie plains, but north on the slopes of the hills. This rock varies in appearance, according to its metamorphosed state, and this according to its locality. Sometimes it is a hard sandstone, with cavities, frequently full of small crystals. Sometimes it is more shaly. In other places, again, it is soft and shaly; in some places of light red, but in others of a deep red.

I found only one fossil in one of the lower limestones (a purple-colored limestone) of the series which Prof. J. S. Newberry, M. D., pronounced to be *Athyris subtilis* of the carboniferous age. Plate III is a section I took from a spot above Camp Walbach. The prominent red sandstone occupies a place three or four layers of rocks above the upper one of these. The series of the less metamorphosed rocks comprises the rocks from the granite, or more metamorphosed rocks, to four or five layers above the red sandstone. They are mostly limestones, one being very hard and another an oölitic limestone.

From Dr. Hayden's account of similar formations on the Black Hills, between the forks of the Cheyenne river, northeast of the hills I visited, (in which he found many fossils, thus fixing their age,) this red sandstone would be of the Jurassic period. But there is a similar formation found south of these hills, explored by Prof. Newberry, and in which he found numerous fossils, showing their Triassic period. Having found no fossils in those I saw, I could but infer that they belong to one of these two, which are contiguous.

The rocks overlying those mentioned above are more sedimentary in their appearance, and are not, as far as I have seen them, at all metamorphosed. They are seen most generally at the foot of the hills, forming frequently valleys parallel to the range, and they also underlie the bot-

tom of the basins occupying the foot of the hills. The following figure shows a section of such formations as are seen in parallel valleys to the range.

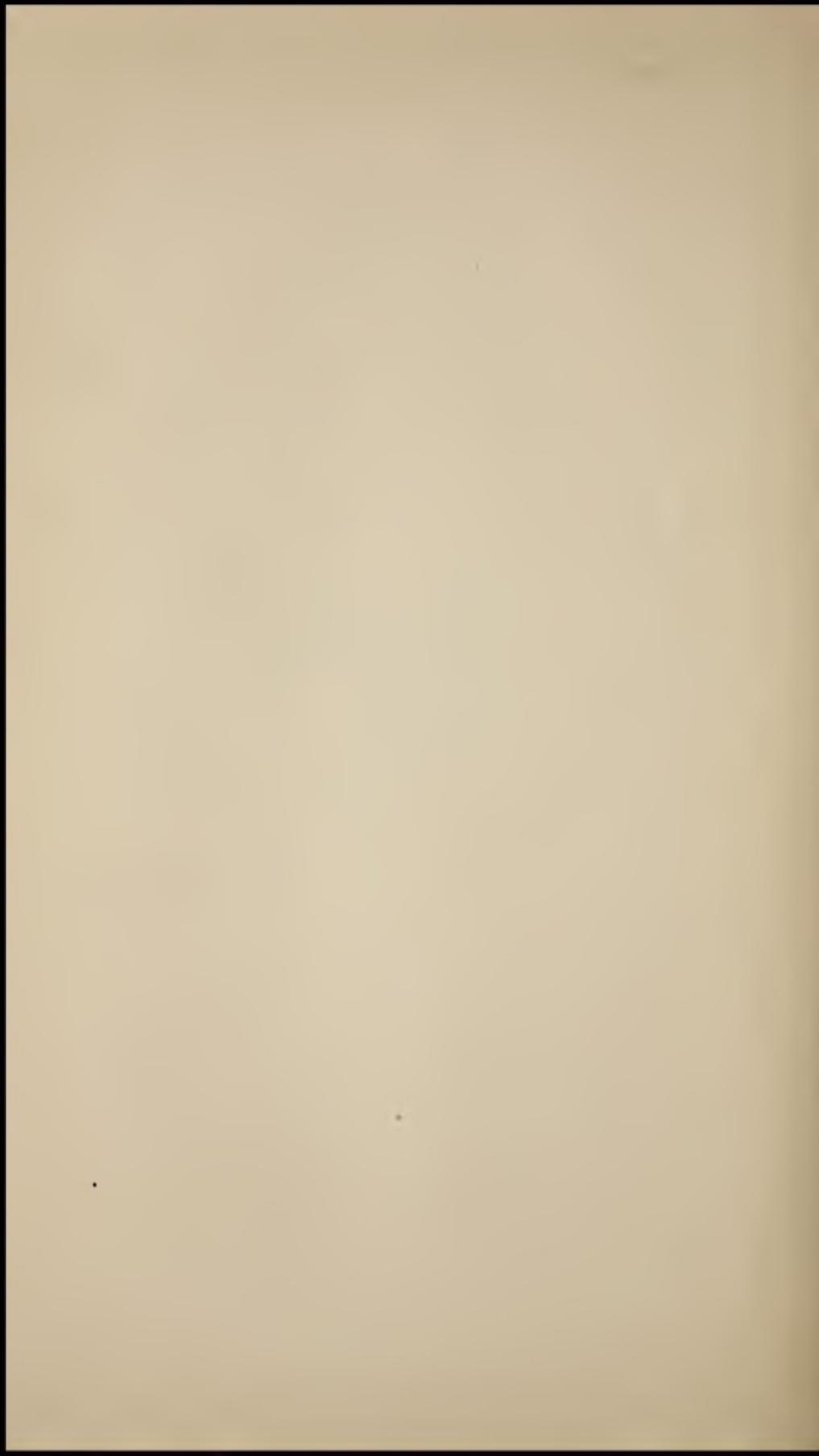
I have not been able to visit these rocks thoroughly, having passed where they occur always in great haste. They occur at La Porte, near the foot of the hills, and extend north for several miles along the foot-hills of the range, coming down into the plains. I found one bed uplifted at about an angle of 75° , with an easterly dip and a north-northeast strike, having a width of about 350 to 400 feet, about 2 miles east of the upper road from La Porte to Fort Laramie, north of the Box Elder. It is traceable on the low bluffs some 5 or 6 miles. This rock is a rather coarse sandstone, containing many fossil shells, petrified wood, and pieces of highly-colored jaspers. The shells prove to be of the middle and upper cretaceous age. They are the *Scaphites nodosus*, *Inoceramus problematicus*, and *Baculites compressus*.



In this place the red sandstone, and a white carbonate of lime very nearly overlying it, is seen from a distance on the higher foothills, producing a striking contrast of color. I noticed among these rocks bituminous shales and white, shaly rock, like fire-clay. Some members of our party came also upon a marly yellow rock, with crystals of gypsum. In the basin of the Lodge Pole creek I noticed a bituminous shale, on a tributary of the Horse Shoe. In the Laramie plains I found a white carbonate of lime, with layers of small shells—*Ostrea congesta*, of the middle cretaceous. Also at about 20 miles from the western entrance of the Laramie

PLATE IV.





cañon is a pond about a quarter of a mile long, with very alkaline water, and surrounded by loose marly formations which give way to the pressure of the foot. And at about 2 or 3 miles from the last-mentioned place there is a small lake, 2 or 3 miles square, close to the Laramie, called by the party Lake Evans, with very steep banks. Along the western bank there are marly rocks of different hardness, some of them containing an abundance of fossil shells, having their enamel beautifully preserved, showing polychroism as you turn them to the light. They are the *Inoceramus problematicus*, *Amonites placenta* of the upper cretaceous age. I found, also, at about 5 or 8 miles from this place, a bed of clayish carbonate of iron ore, overlaid by a whitish shale.

The next formations, which apparently overlie the last-mentioned, are coal beds of lignite. I have already made mention of these rocks in my report on the Crow creek line. I will only repeat the main facts with regard to them.

I first saw them on the Crow creek at about 25 miles from its mouth; and here it is about 40 miles from the mountains, in a direct line. They are thin here. The underlying rock, seen at about 2 miles from the mouth of Crow creek, is a blueish limestone, with a few fossil shells—*Pholodomga fibrosa*, middle cretaceous. Over this, as far as ascertained, occur six double beds of lignite, of from a few inches to about 4 feet thick, separated by brown slate and fire-clay, and in the upper beds, also, by soft yellow sandstone, with iron ore in masses and nodules; and over the whole these last rocks occur again in thicker beds, with smaller quantities of iron ore. They are separated by two small beds of shells and one of conglomerate. These shells are the *Ostrea inornata* of the upper cretaceous. The inclination of these formations is a little towards the southeast, hardly perceptible. They are irregular in thickness.

Two similar beds of coal, with sandstone containing iron ore in small quantities, occur on the high table-land northeast of La Porte, at about 15 to 18 miles from the mountains. They are thicker than the Crow creek beds, and have the same inclination.

Again, at about 50 miles southwest of La Porte, at Belmont, Colorado, several beds of coal, with sandstone containing iron ore, brown slate, and fire-clay, occur. They are about 2 or 3 miles from the mountains, and have been folded in small folds, some of the beds being almost in a horizontal, while others are in a vertical, position. They are from 3 to 12 feet thick. From fossil leaves they show their cretaceous age. This would show that the Crow creek valley coal and the last are the same or similar beds. They possibly may be different beds of the same formation.

Above all the rocks already mentioned come the nearly horizontal formations of the prairies. They form all the table-lands along the Lodge Pole, along a portion of the Crow, a portion of the Chugwater, and the Laramie river east of its cañon. They outcrop in many places along the valleys of these creeks and river. The nature of these rocks is varied. The first outcrop, noticed at about 10 miles west of Julesburg, is a soft, marly, white rock. Four or five miles higher up the valley, on the bluffs, occurs a conglomerate about 5 feet thick, having under it a sandstone, cemented together by carbonate of lime, a few feet thick, and again, under this, a soft, marly, crumbling rock, showing very irregular lines of stratification, as shown in Plate IV.

At about 36 miles from Julesburg you see the outcrops of the rocks along the bluffs on both sides of the valley, as shown in the sketch. They consist of about a foot of conglomerate, followed by similar beds mentioned above. The softness of the underlying rocks gives great boldness to the appearance of these bluffs, they being sometimes washed away under the harder rocks above, which break and slide down. At about 15 miles above this point, these formations are seen repeated in succession, as shown by Plate V.

Thus, in going up the valley, you see similar formations repeatedly renewed, with some modifications, some presenting very hard limestone, with varied thickness. The top-most is seen on the highest table-lands opposite to the Black Hills, and is at top a conglomerate; then a calcareous sand-

MANGROVES 50.

PLATE V.





stone; then a hard limestone; then a soft, marly rock; and again a conglomerate. The conglomerates and sandstones are composed of ingredients of the metamorphic rocks of the hills.

On the lower part of the Chugwater similar formations are seen, occurring in great thickness. The conglomerate noticed in one place had a thickness of 12 to 15 feet. Here, also, the washing away of the under soft rock gives shape to the banks of this valley, which imitate, at a distance, the ruins of fortifications with towers. Plate VI.

The peculiarity of these rocks along the Laramie river is their thickness. In some places a conglomerate occurs, consisting of large pebbles of that part of the Black Hills, cemented with white carbonate of lime. I did not find any fossils in them; but on comparing Dr. Hayden's account of similar rocks found northeast of this place, whose age he determined by fossils, I would suppose them to be miocene and pliocene of the tertiary.

With regard to the lignite occurring in some parts referred to already, and the probabilities of its spreading under the whole country, I would call your attention to the fact that the tertiary of the prairies lies unconformably to the older formations. This is evidently seen in the valley bordering the foot of the Black Hills, from the Crow creek to the Chugwater. You have here on the west the uplifted rocks of the hills, in some places at an angle of 75° to 80° ; and on the opposite side, towards the east, is the horizontal strata forming the table-lands rising up above the valley. The valley is from 6 to 8 miles wide. But at the Chugwater an additional fold, apparently of the main, stretches farther east, so that the uplifted comes in closer proximity to the horizontal strata, and here I noticed them lying unconformably in close connection. This is also the opinion of geologists who have investigated this fact more thoroughly than myself. From this fact it is evident that the upheaval must have occurred sometime during the cretaceous and tertiary. The folded state of the beds at Bellemont shows that it occurred at a subsequent time to this formation. Thus, the basin of

the South Platte would evidently be of later period than the beds, and their appearance there would only be consequent to the erosion of the upper rocks. On this ground it would be reasonable to think that the beds existed under the other portions of the country occupied now by the tertiary. It would not be impossible, though, that if these beds were deposited throughout the country, they might have been washed away on such higher uplift before the deposition of the tertiary, so that this subject would require more search to find, if possible, some local indication.

I would call, also, your attention to the fact of the occurrence of bituminous shales at different places, principally in the vicinity of La Porte, which would require more investigation to find out whether they lead to more valuable formations.

The probability of a vein of iron ore on the hills between the head-waters of the Lone Tree and Crow creeks, mentioned more particularly in my report on the Crow creek line, would require more investigation to find out the nature and extent of the vein. The specimen I took is a hematite, but it is evident that it is in this state by decomposition of some other mineral of iron.

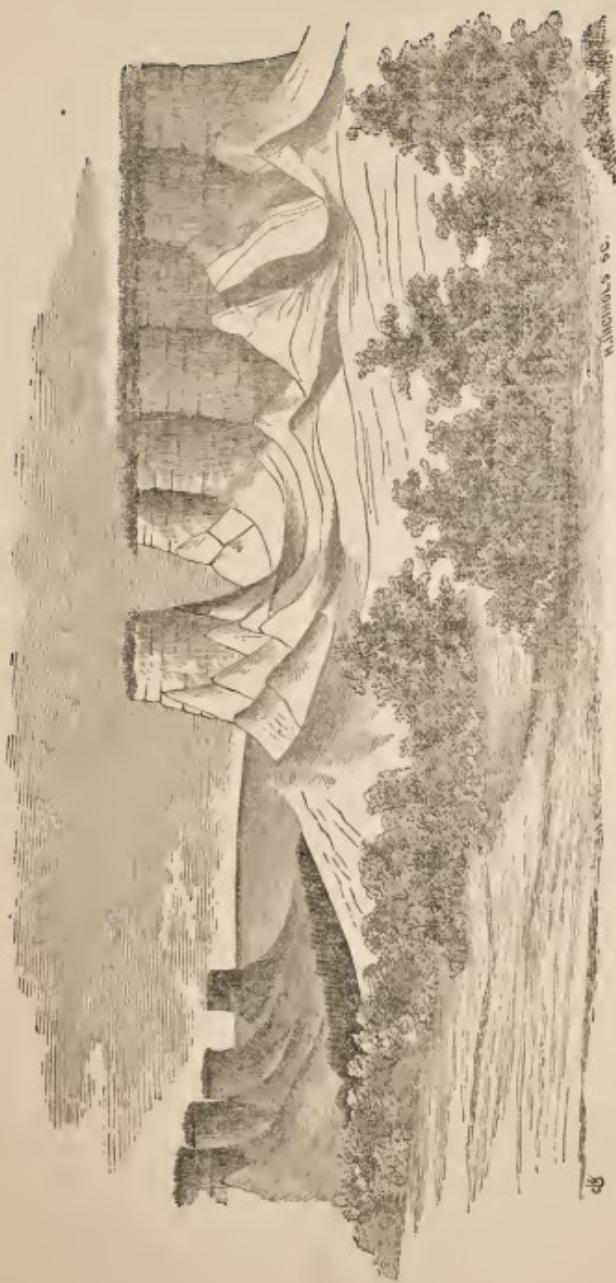
In conclusion, you will notice that on the prairies there are a variety of limestones, marls, and some calcareous sandstones and conglomerates. They are usually soft and thin formations, but many of them are good for building material and for lime. You find, also, clay for brick.

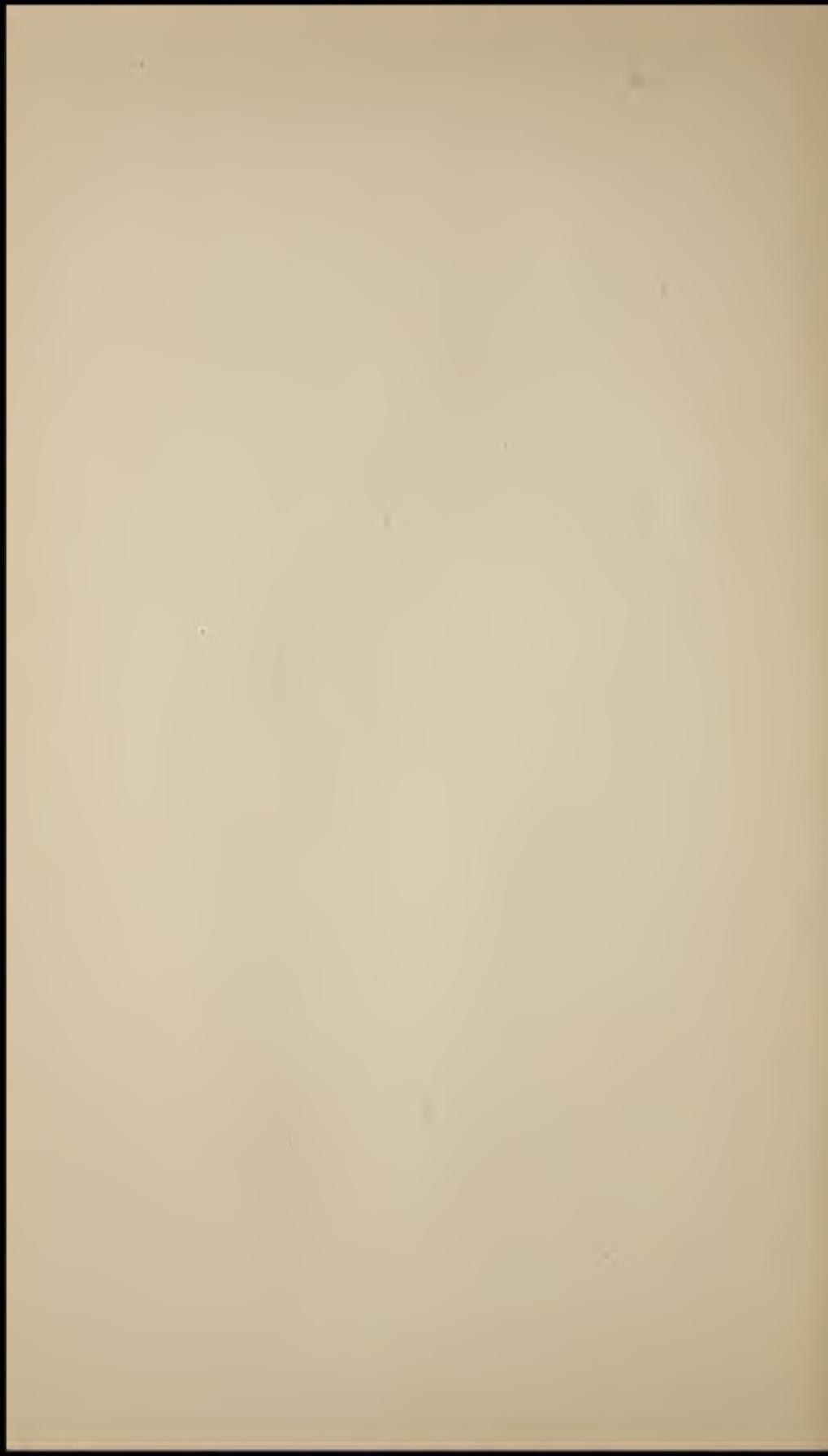
At the foot of the mountains, and on them, however, you find a greater variety of limestones, some sandstones, red slates, diorites, and porphyry, which would offer better material for the same purposes.

In iron ores, the magnetite of the Chugwater, the carbonate of iron of the Laramie plains, a probable vein of iron at the head of the Crow creek, and the hematite and limonite at the lower part of the same valley, would probably be of great economical value, with an abundance of fuel for working them, or by more easy means of transportation. I was told of the existence of a sufficient supply of timber at

PLATE VI.

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about 10 miles from the spot where the magnetite occurs, for the smelting of this ore.

The lignite, in the absence of other fuel in the country, may be found profitable and useful for ordinary purposes. It is a poor fuel for metallurgical purposes.

Of the more precious metals, I have not found any. I frequently met large veins of quartz, which were apparently barren.

I am indebted to Prof. J. S. Newberry, of the School of Mines, of this city, for the naming and determining the age of all the fossils I brought with me.

I remain, respectfully,

Your obedient servant,

DAVID VAN LENNEP,

Geologist.

